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(12) **United States Patent**  
**McAuley et al.**

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(45) **Date of Patent:** **Jul. 7, 2015**

(54) **BREATHING ASSISTANCE APPARATUS**

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(73) Assignee: **Fisher & Paykel Healthcare Limited**, Auckland (NZ)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 947 days.

(21) Appl. No.: **12/502,528**

(22) Filed: **Jul. 14, 2009**

(65) **Prior Publication Data**

US 2010/0006101 A1 Jan. 14, 2010

**Related U.S. Application Data**

(63) Continuation-in-part of application No. 10/599,394, filed as application No. PCT/NZ2005/000062 on Mar. 30, 2005.

(60) Provisional application No. 61/082,007, filed on Jul. 18, 2008, provisional application No. 61/082,974, filed on Jul. 23, 2008, provisional application No. 61/083,554, filed on Jul. 25, 2008.

(30) **Foreign Application Priority Data**

Apr. 2, 2004 (NZ) ..... 532108

(51) **Int. Cl.**

**A61M 16/06** (2006.01)

**A61M 16/10** (2006.01)

**A61M 16/16** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ..... **A61M 16/06** (2013.01); **A61M 16/0683** (2013.01); **A61M 16/0816** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC ..... A61M 16/06; A61M 16/0616; A61M 16/0605; A61M 16/0622; A61M 16/0661

USPC ..... 128/205.25, 206.21, 206.24, 206.25, 128/206.26, 206.28

See application file for complete search history.

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*Primary Examiner* — Justine Yu

*Assistant Examiner* — LaToya M Louis

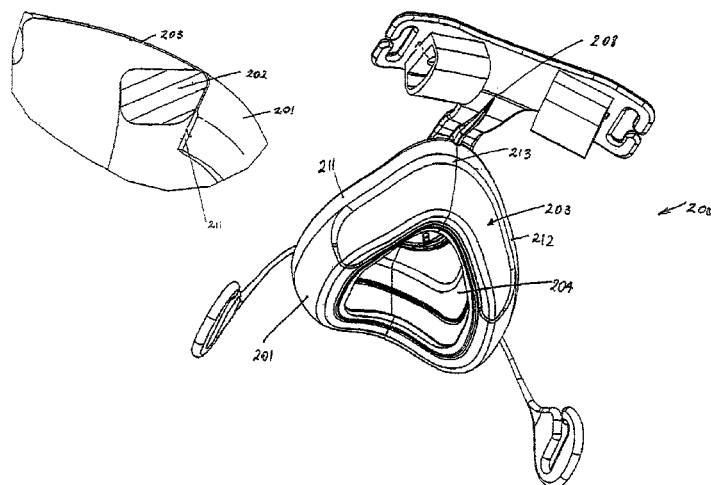
(74) *Attorney, Agent, or Firm* — Knobbe, Martens, Olson & Bear, LLP

(57) **ABSTRACT**

A breathing assistance apparatus is disclosed, for use with delivery of respiratory gases to a patient. The breathing assistance apparatus includes a patient interface, having a body section adapted to cover the nose, or nose and mouth of a patient and a sealing interface. The sealing interface includes at least an outer sealing member. The outer sealing member is adapted to attach to the body section in a sealing manner and has a substantially thin section in at least its nasal bridge region. The thin section is substantially thinner than the rest of the outer sealing member.

The patient interface comprises a mask body and a seal assembly. The seal assembly includes a flexible seal, and a rigid seal clip, the seal assembly being removably attached to the mask body via the rigid seal clip. The mask body and rigid seal clip are profiled to match the contours of a user's face so that the seal has a substantially constant wall depth.

**8 Claims, 37 Drawing Sheets**



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		(2013.01); <i>A61M 16/16</i> (2013.01); <i>A61M</i>	7,077,126 B2 *	7/2006	Kummer et al. ....	128/200.23
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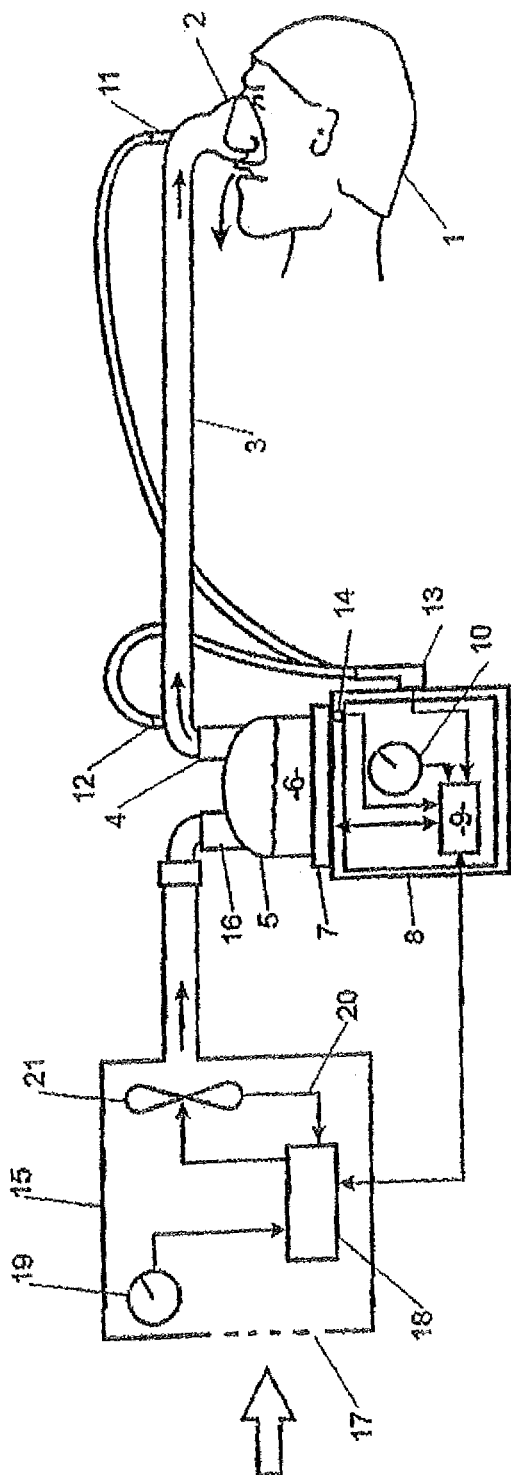


FIGURE 1

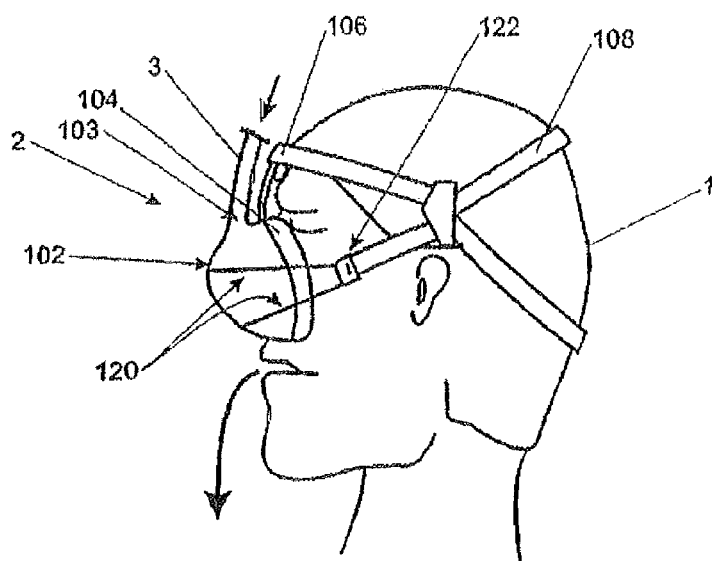


FIGURE 2

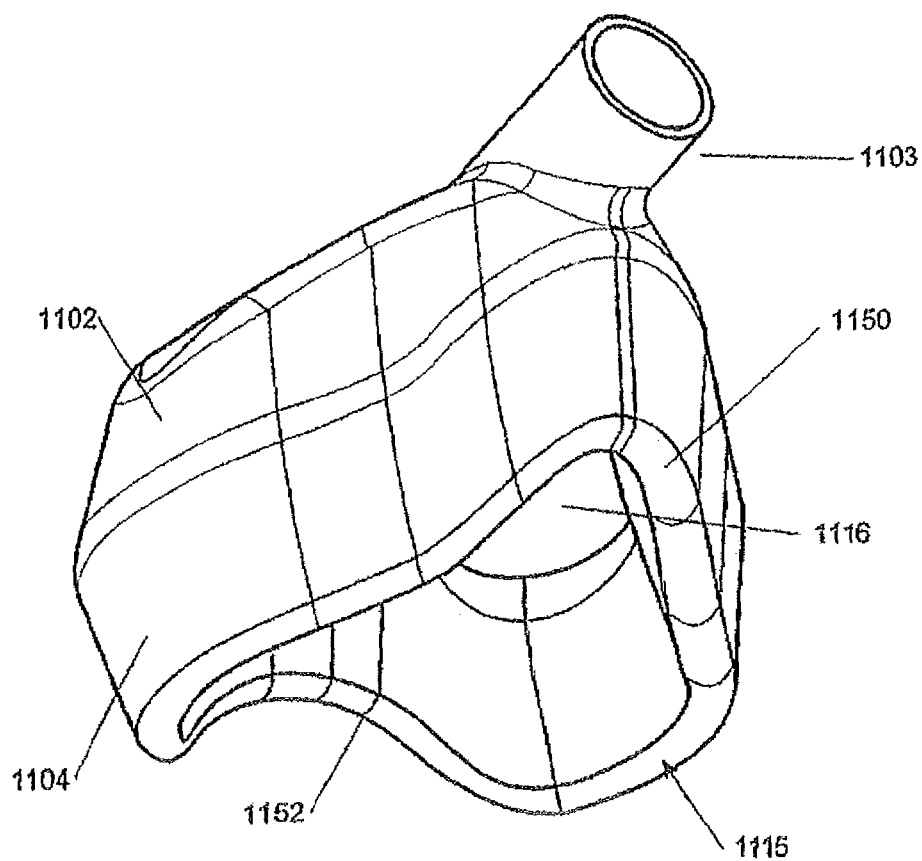
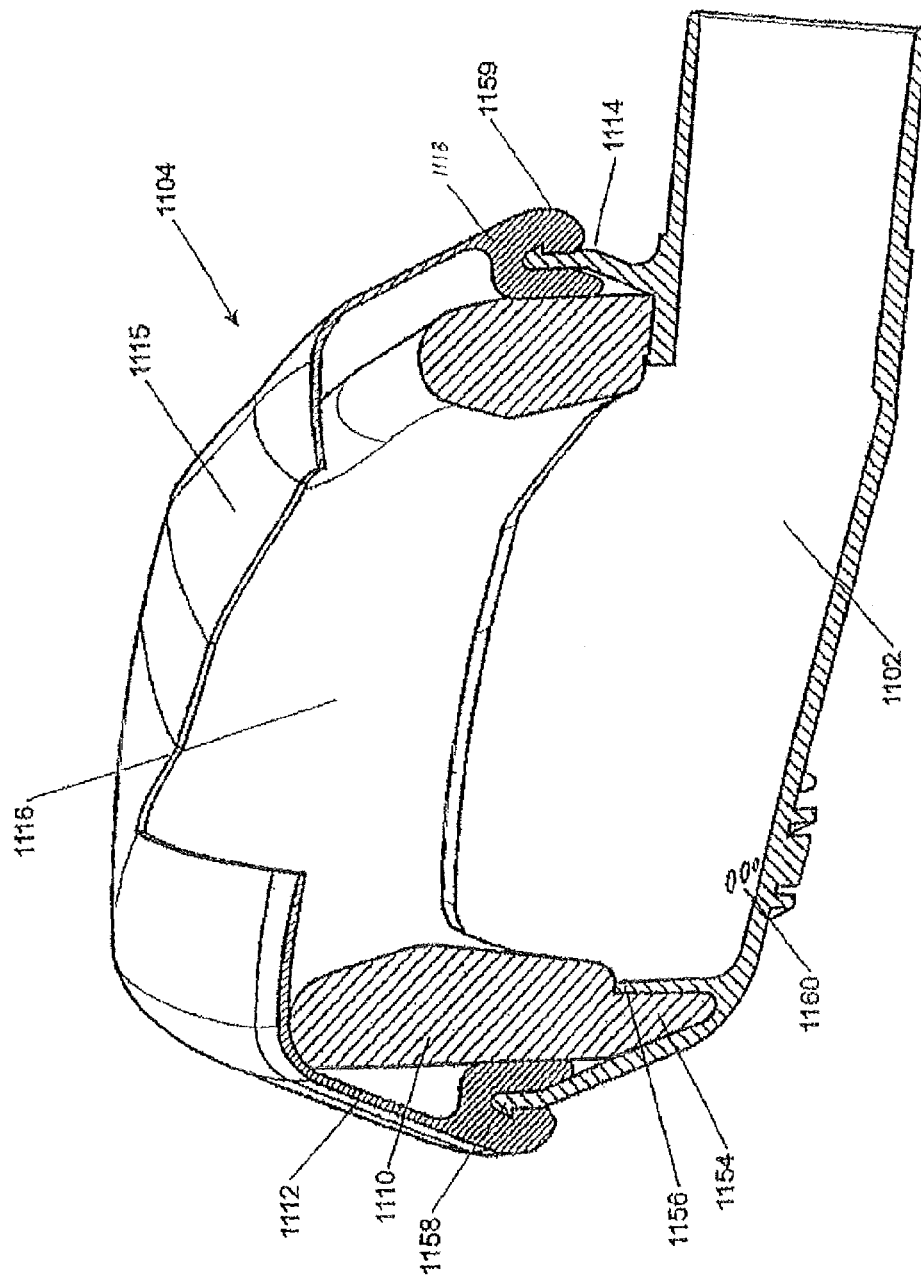


FIGURE 3



**FIGURE 4**

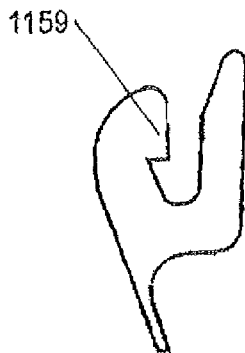


FIGURE 5

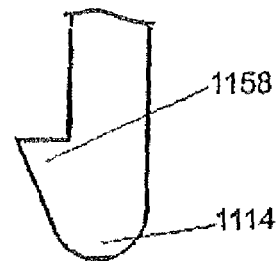


FIGURE 6

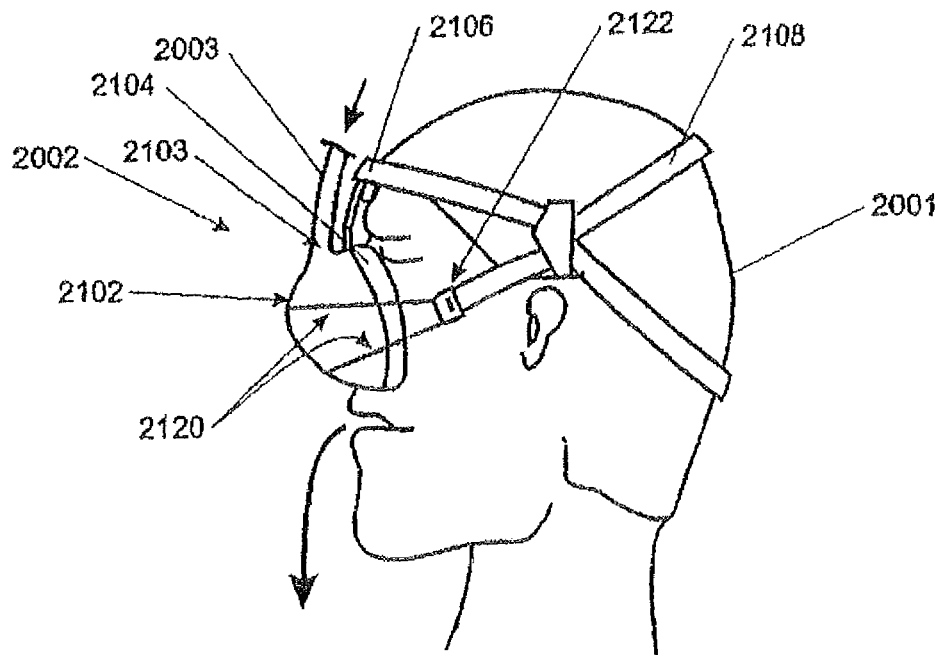


FIGURE 7

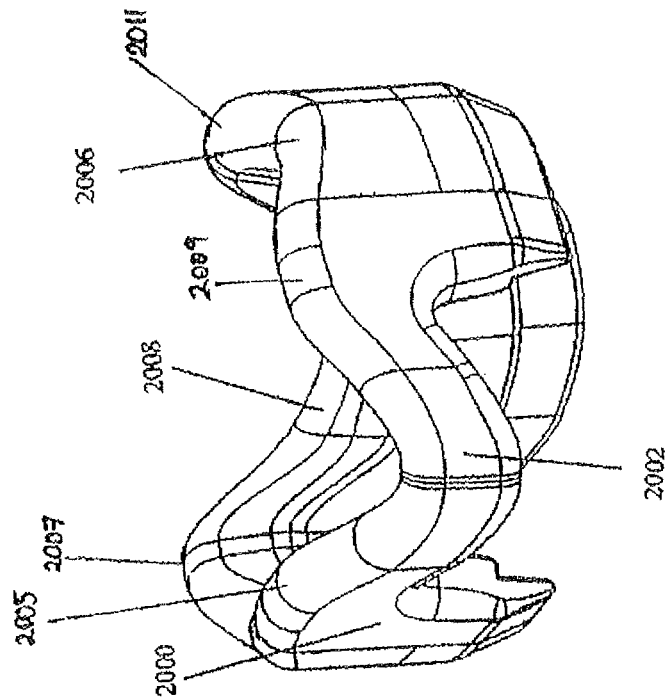


FIGURE 9

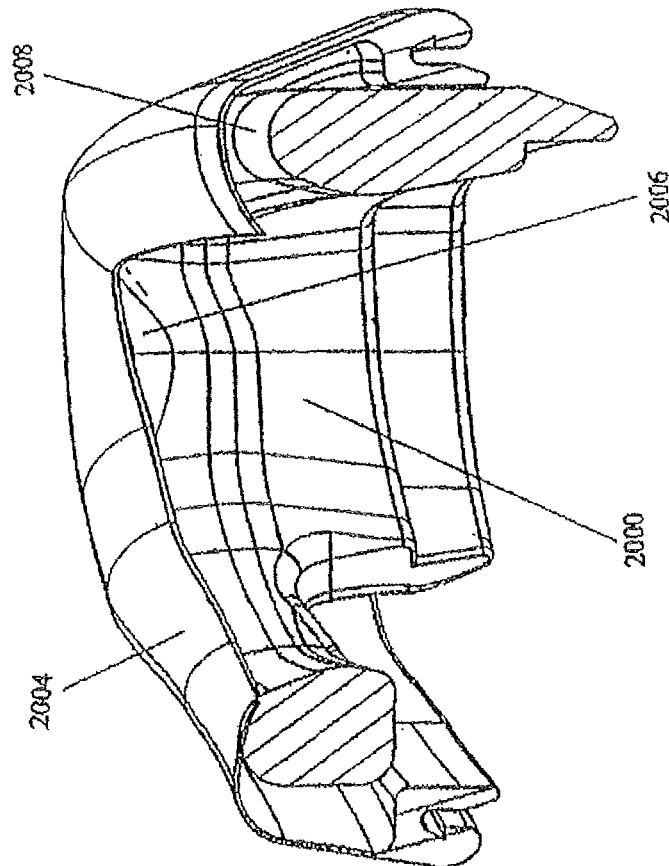


FIGURE 8



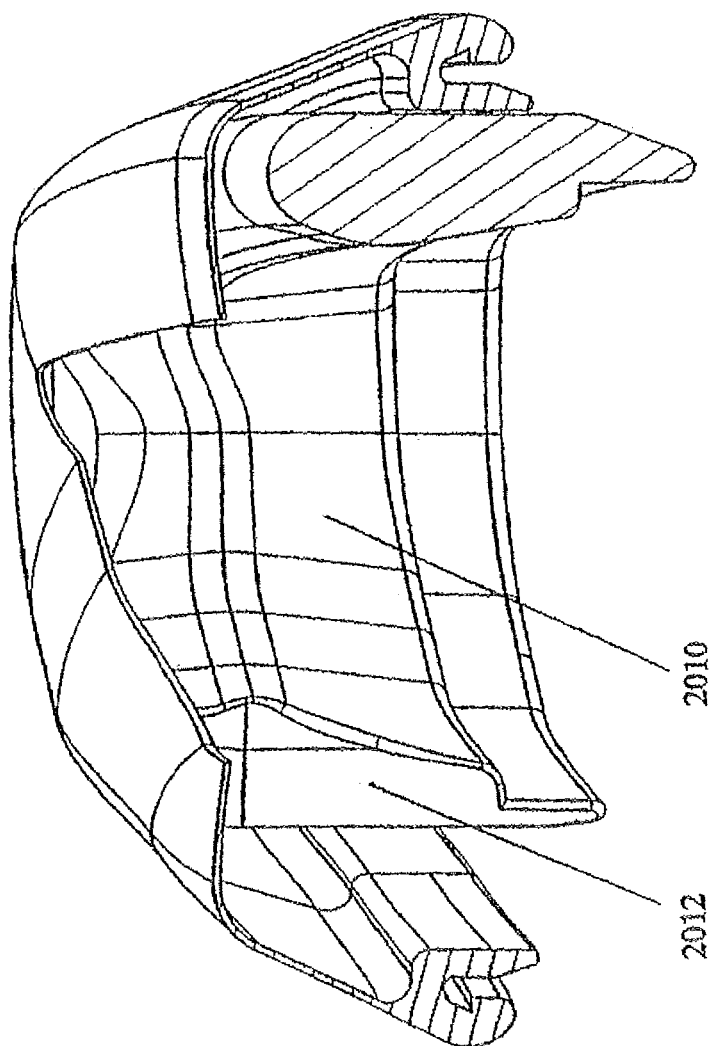


FIGURE 10

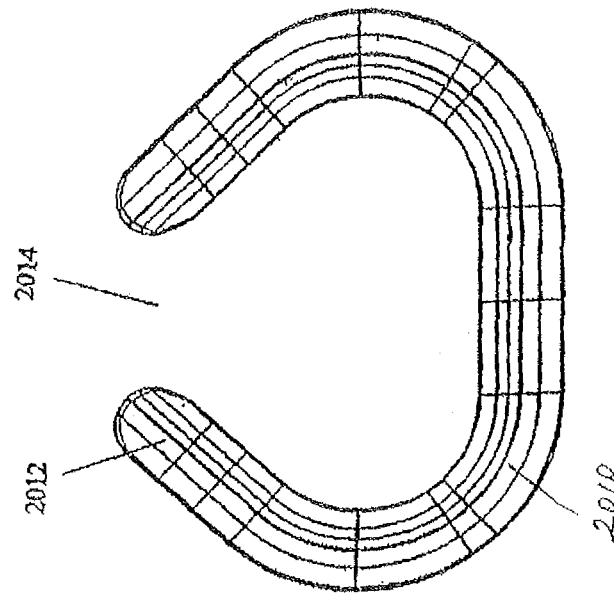


FIGURE 12

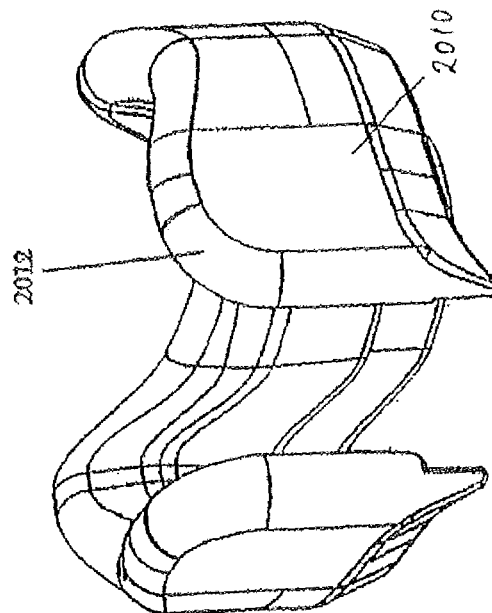
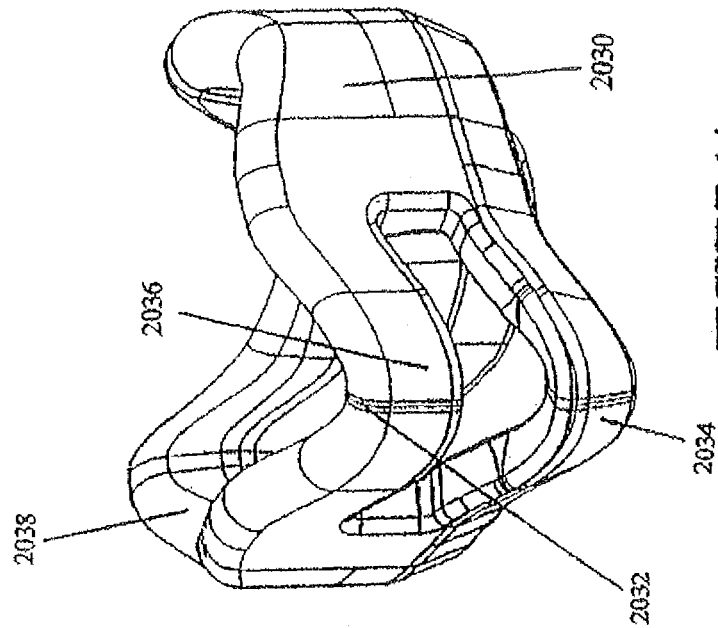
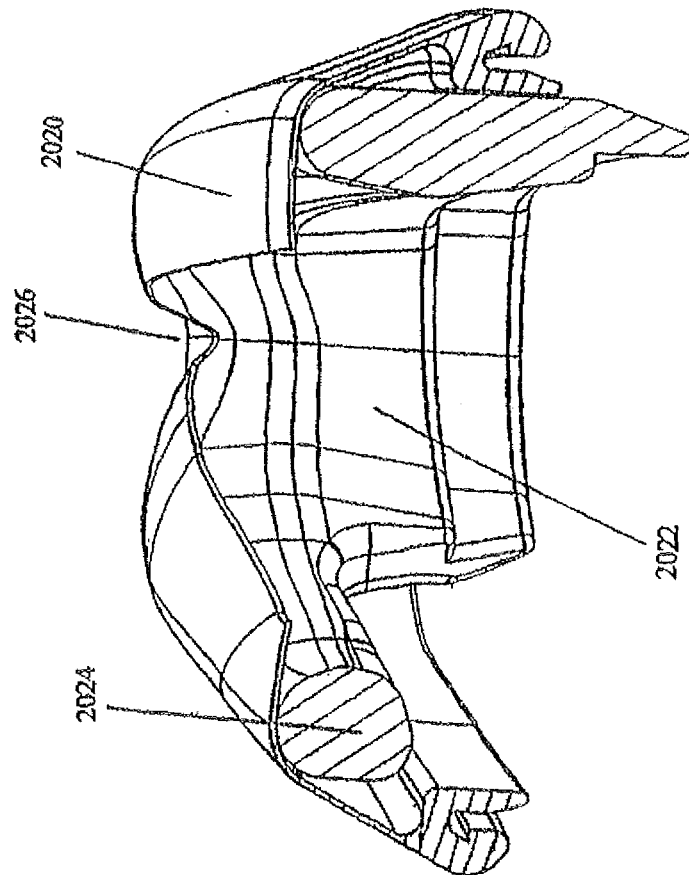


FIGURE 11



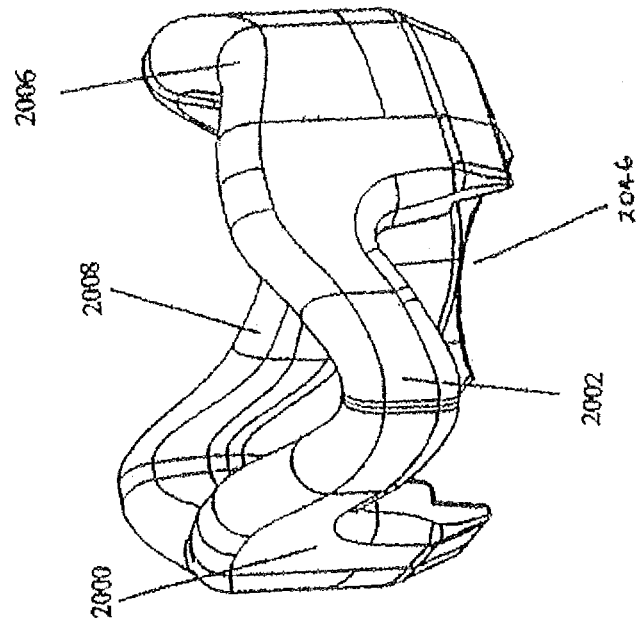


FIGURE 16

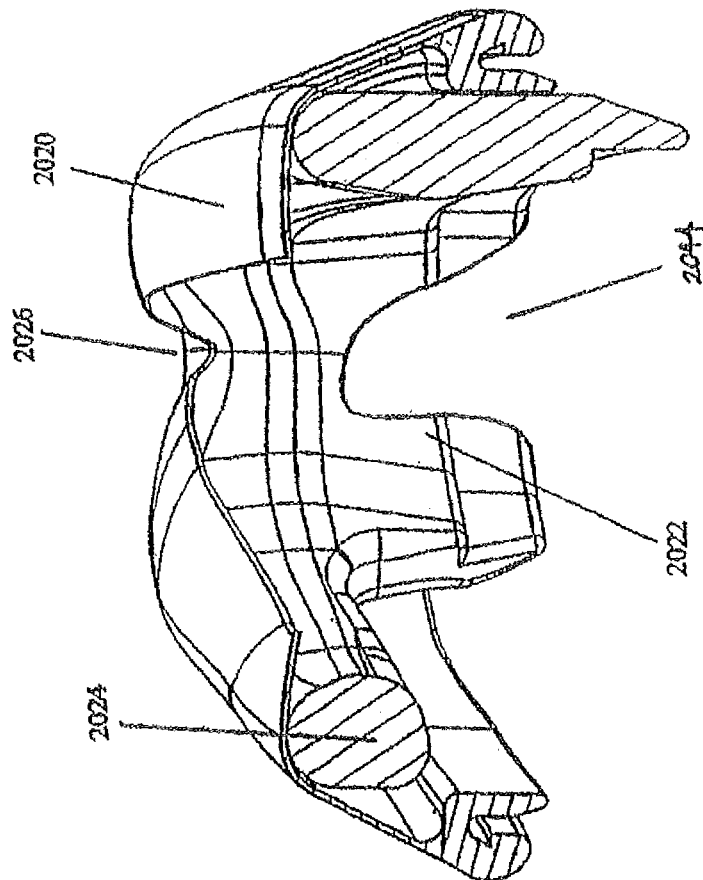


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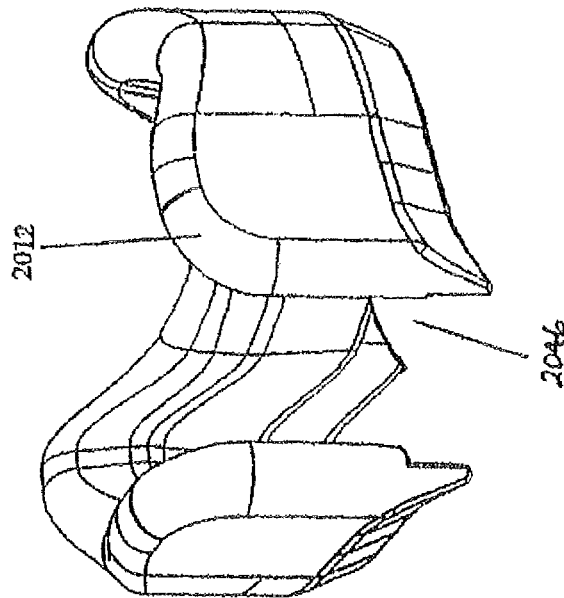


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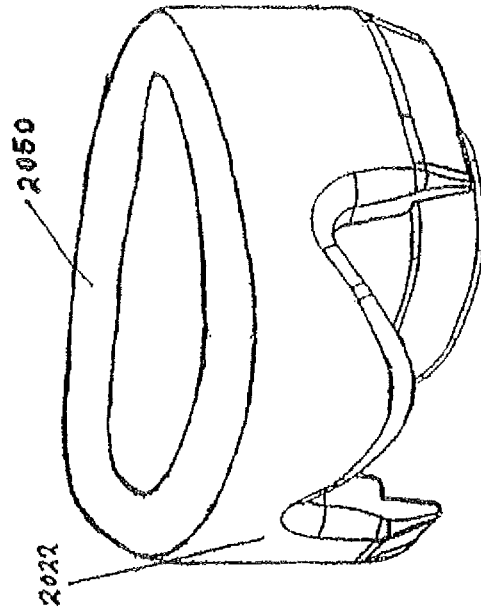


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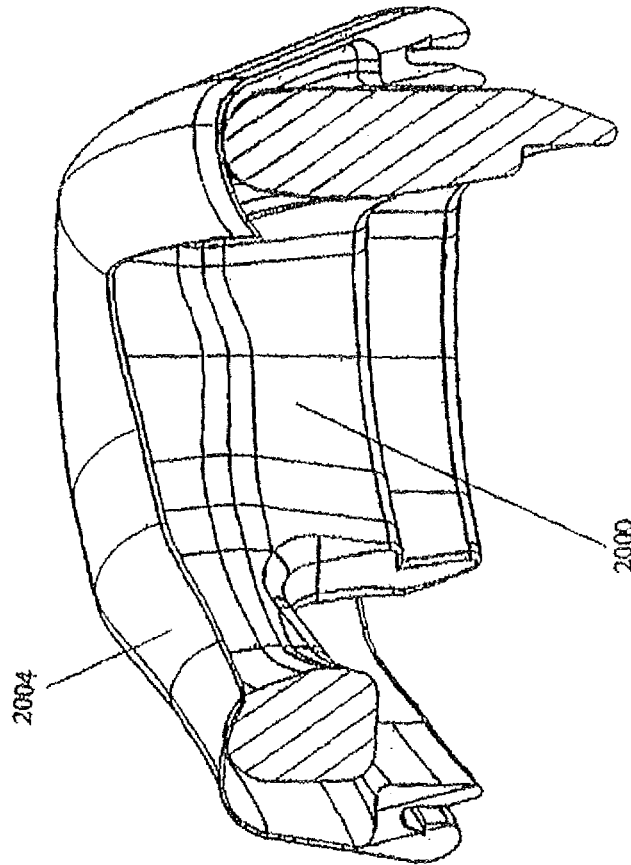


FIGURE 20

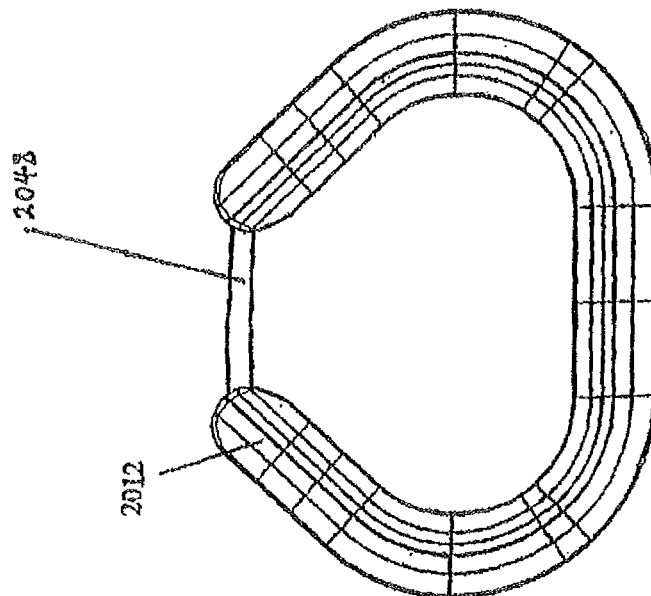


FIGURE 19

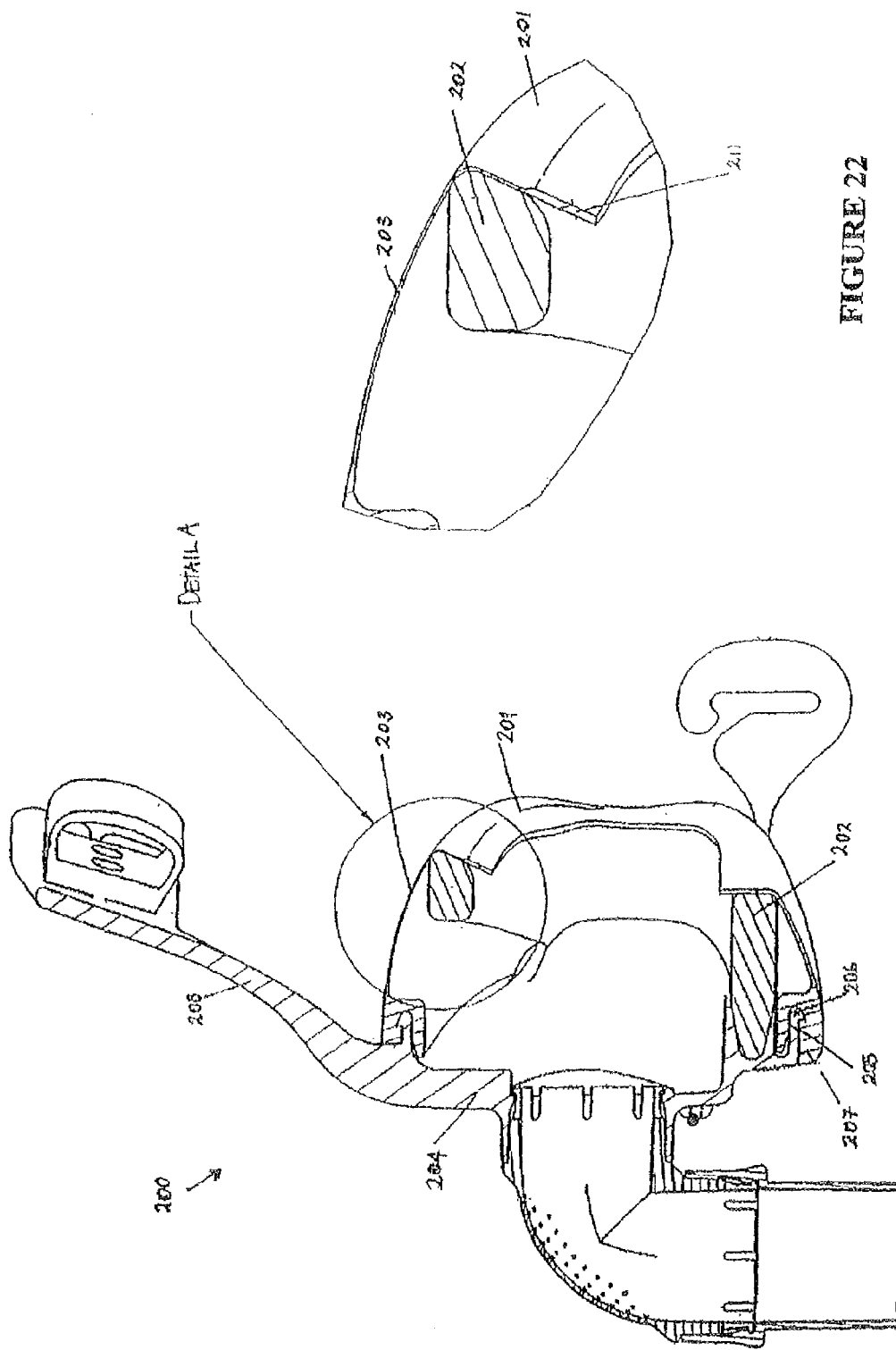
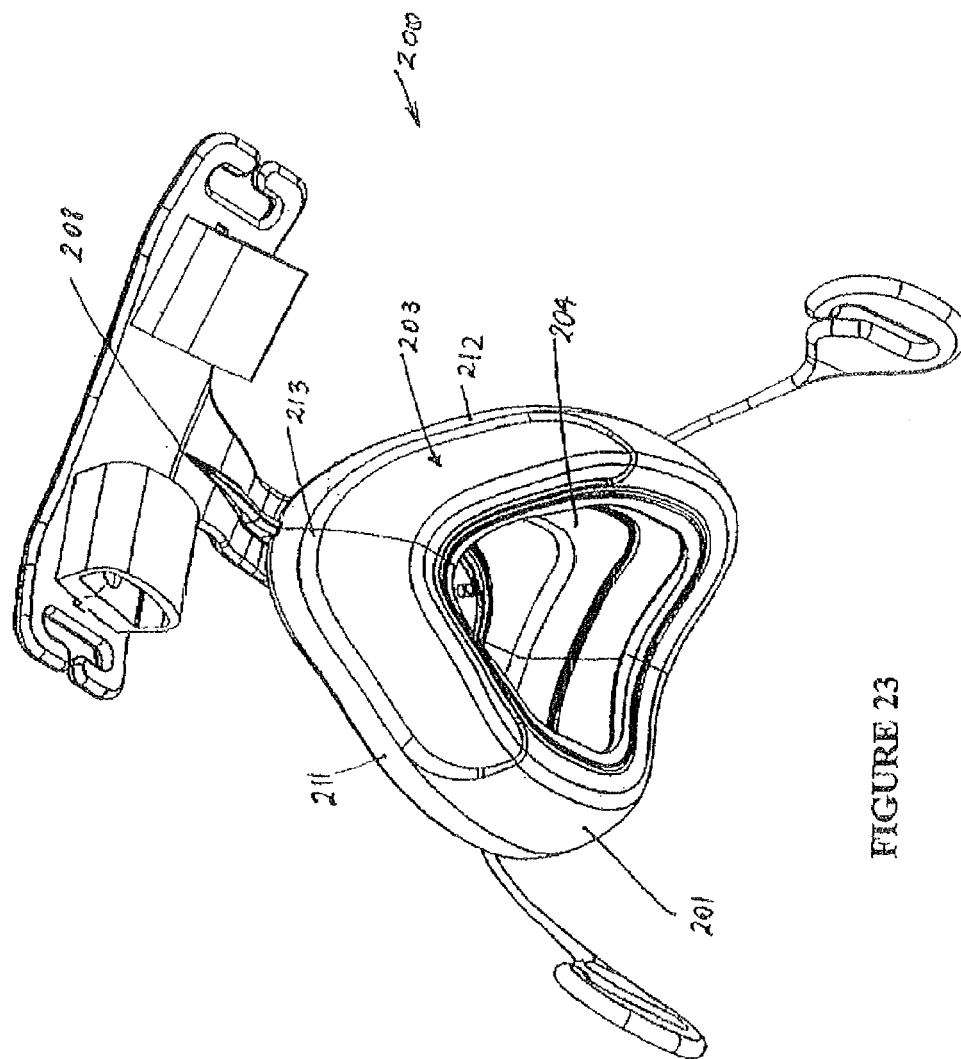


FIGURE 22

FIGURE 21





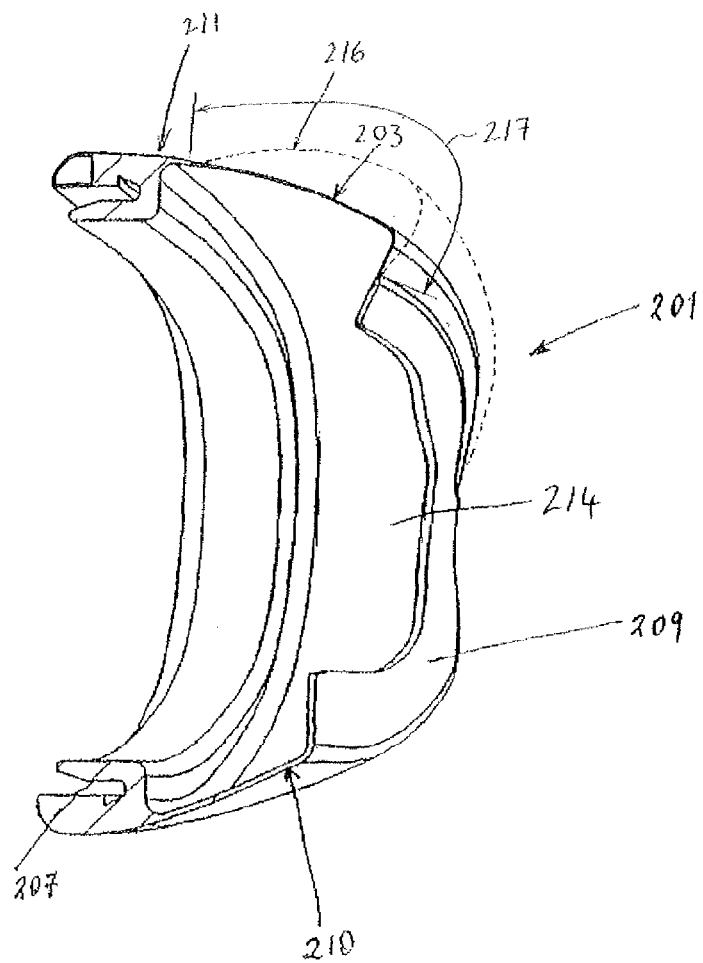


FIGURE 24

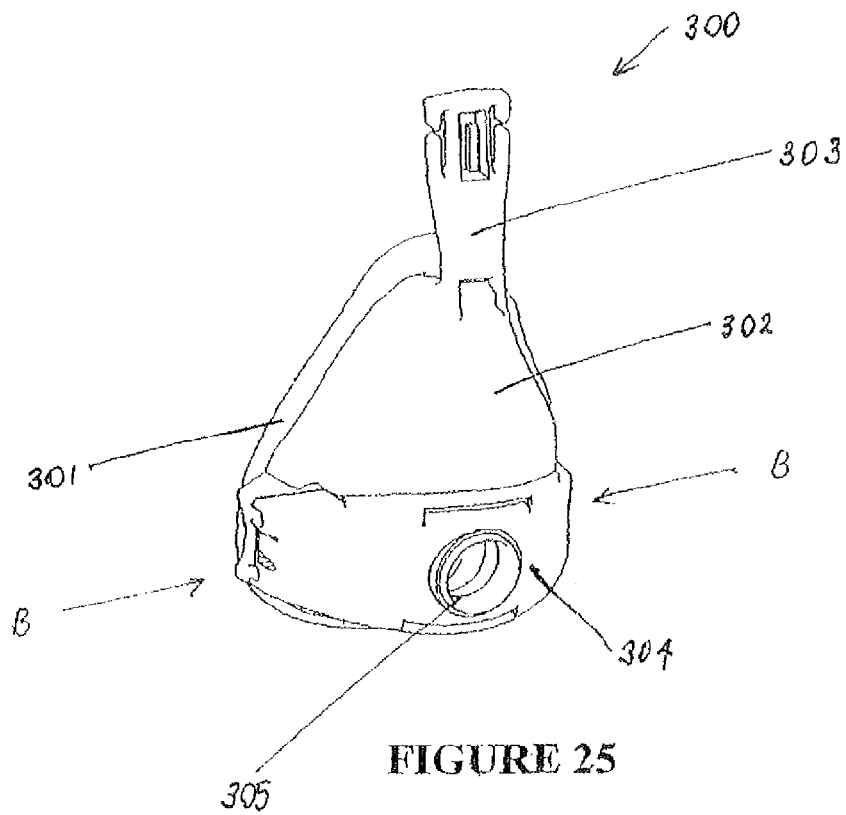


FIGURE 25

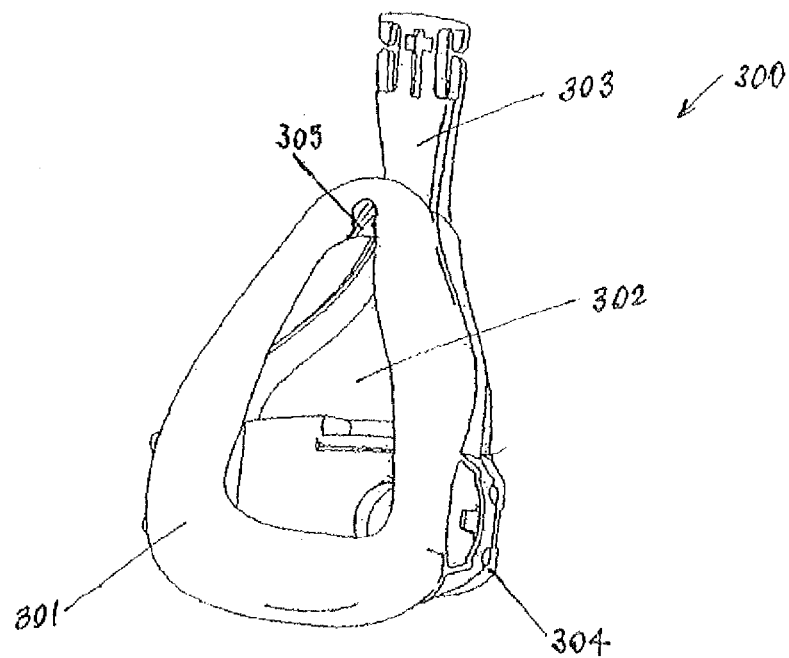


FIGURE 26

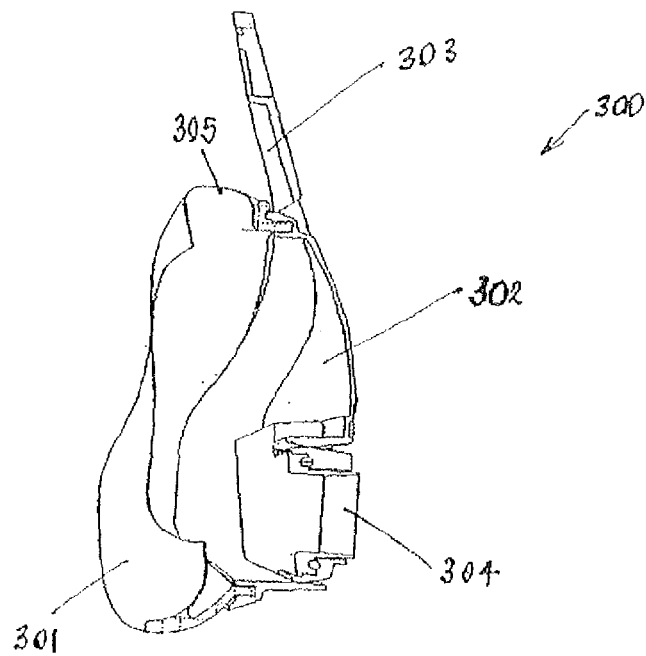


FIGURE 27

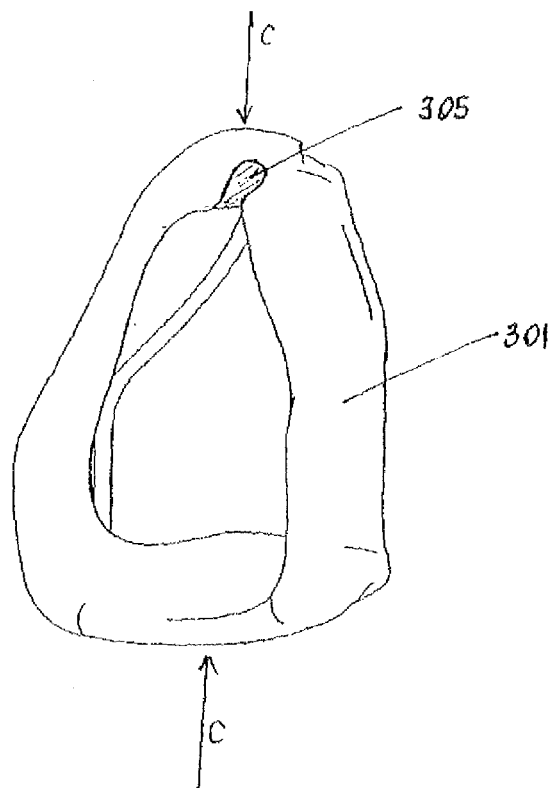


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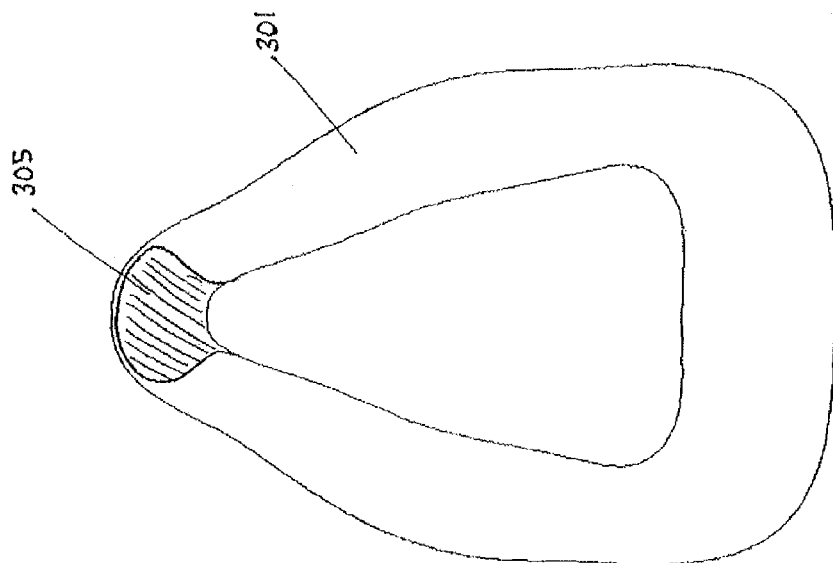


FIGURE 30

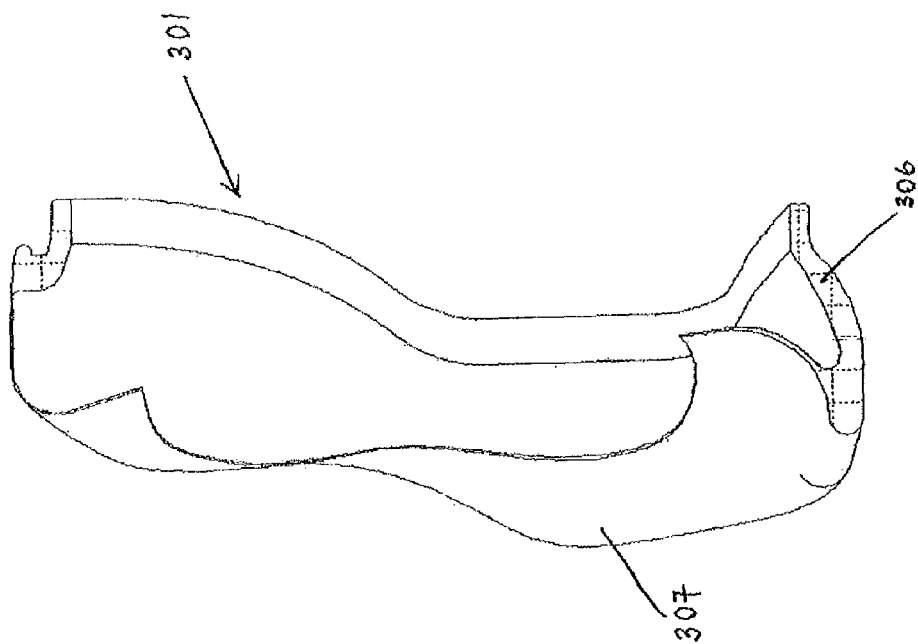
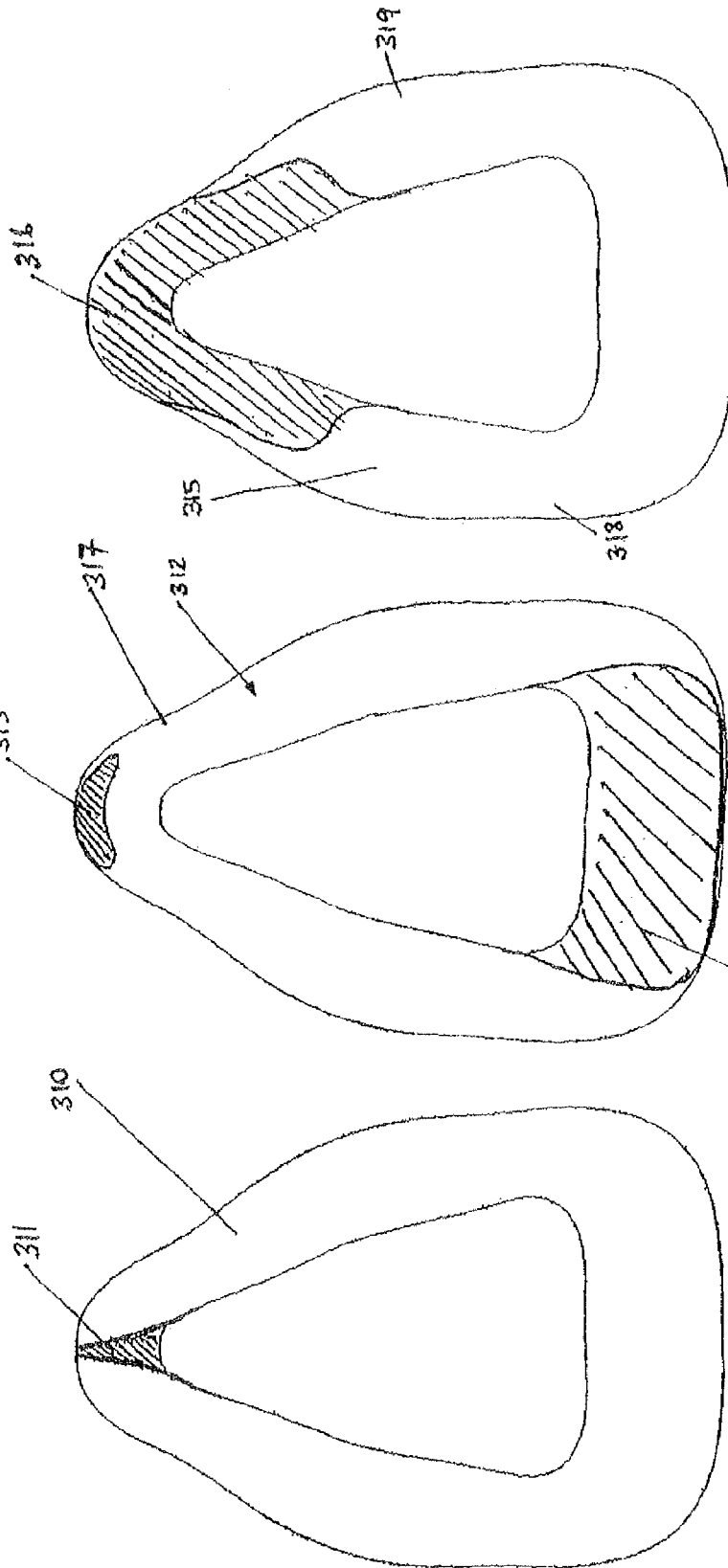


FIGURE 29



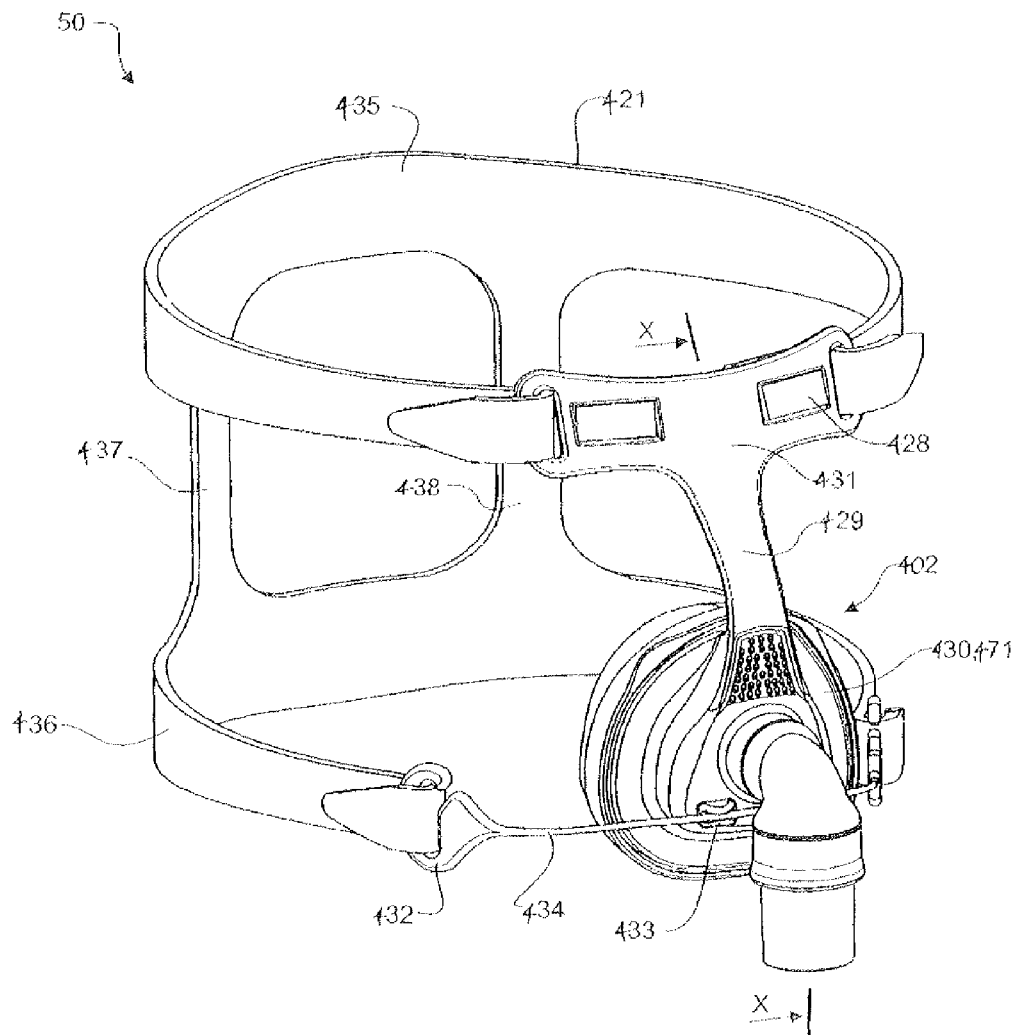
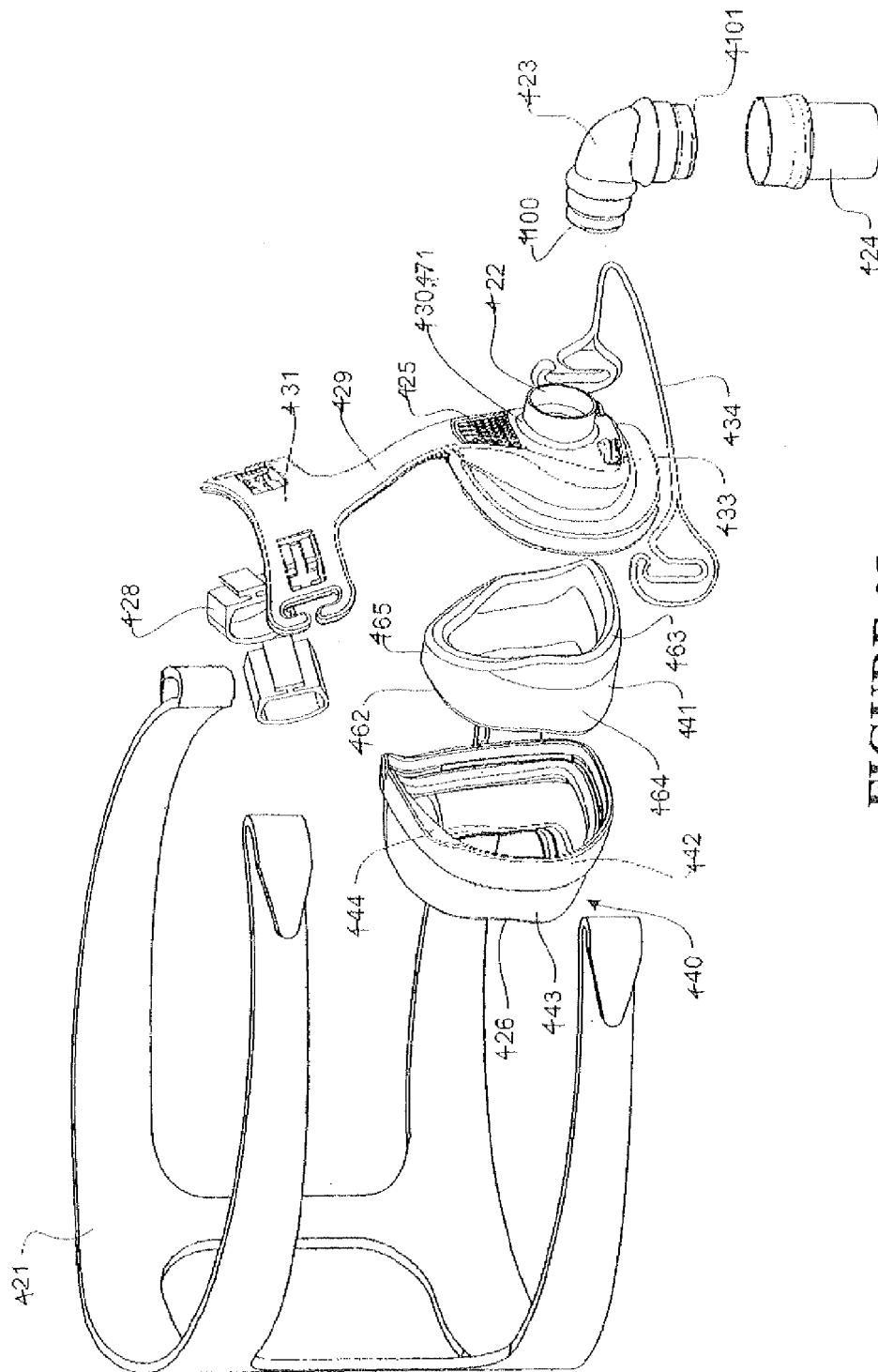


FIGURE 34



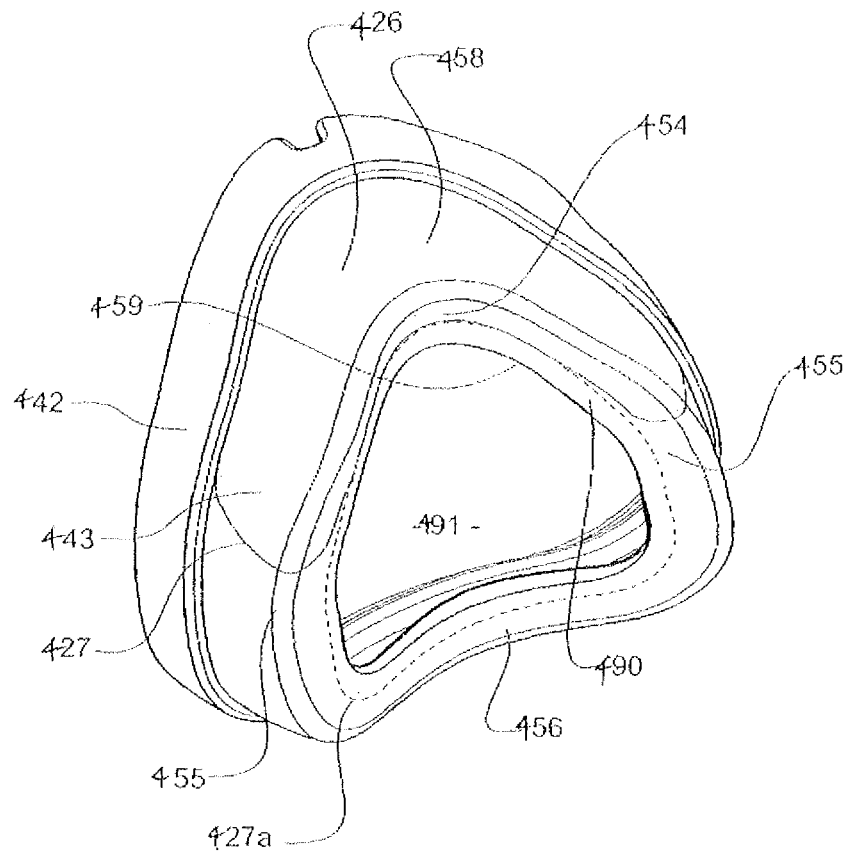


FIGURE 36A

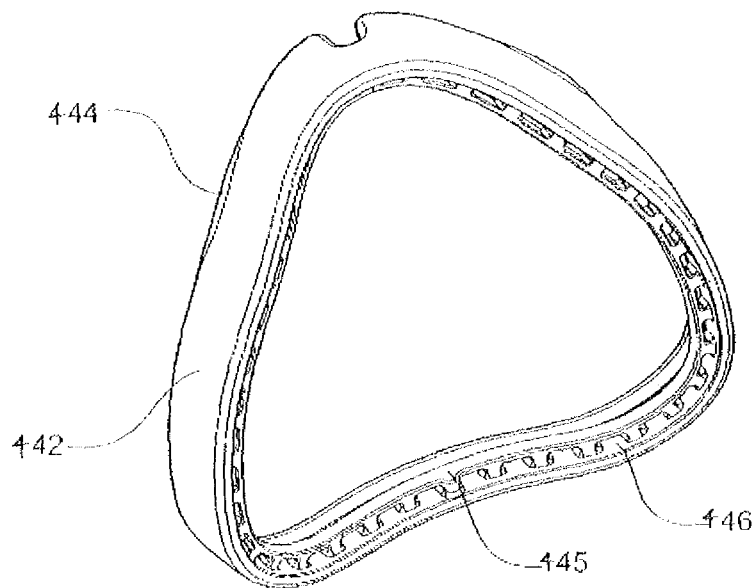


FIGURE 36B



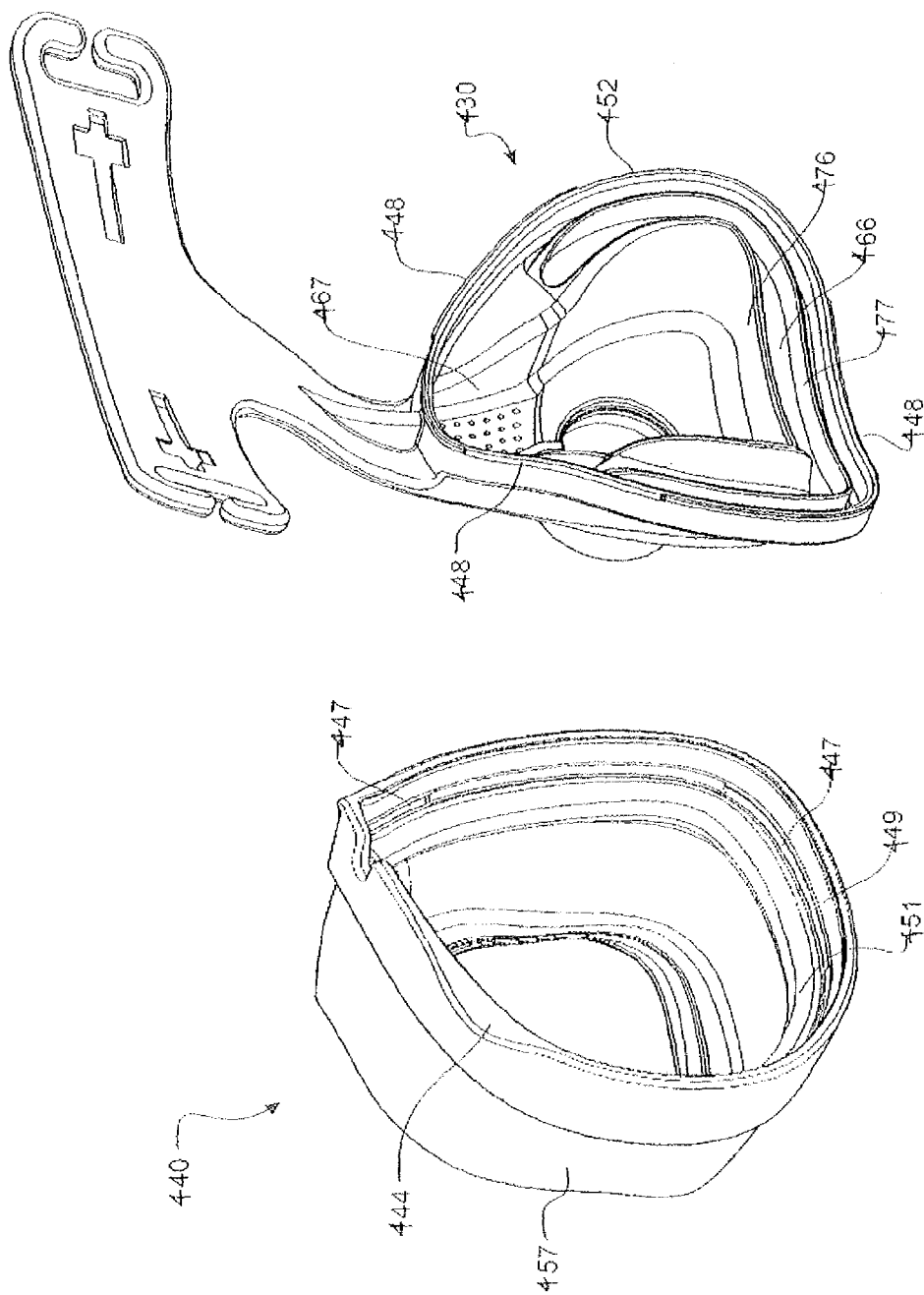


FIGURE 37

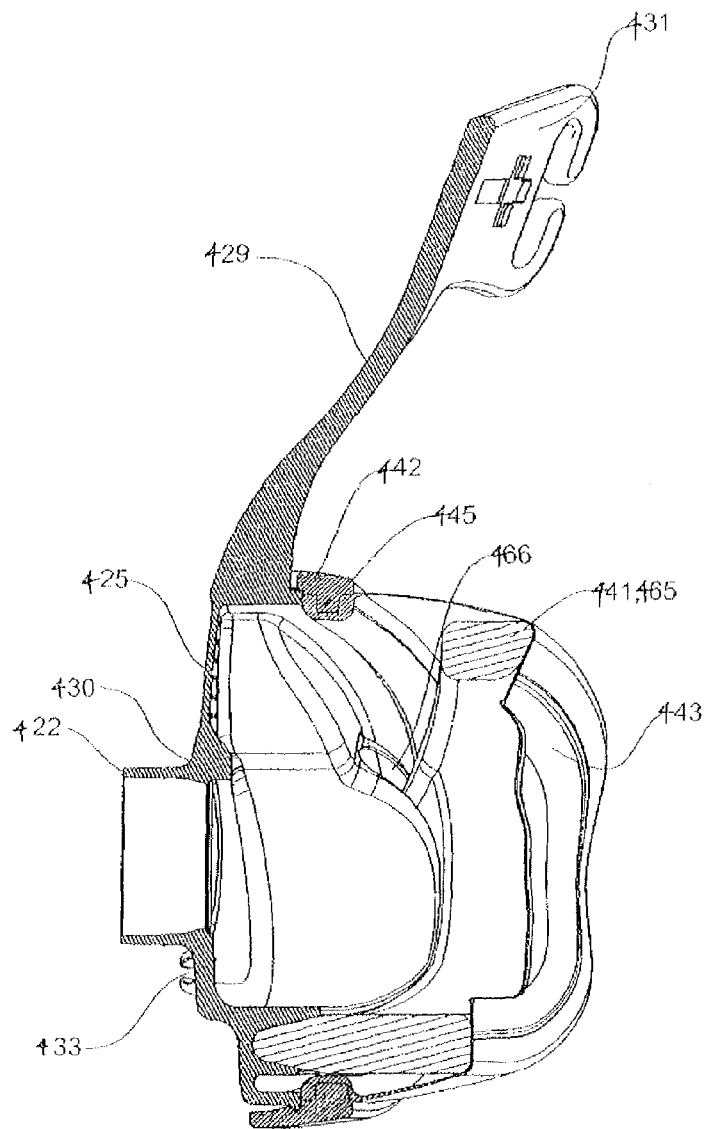


FIGURE 38

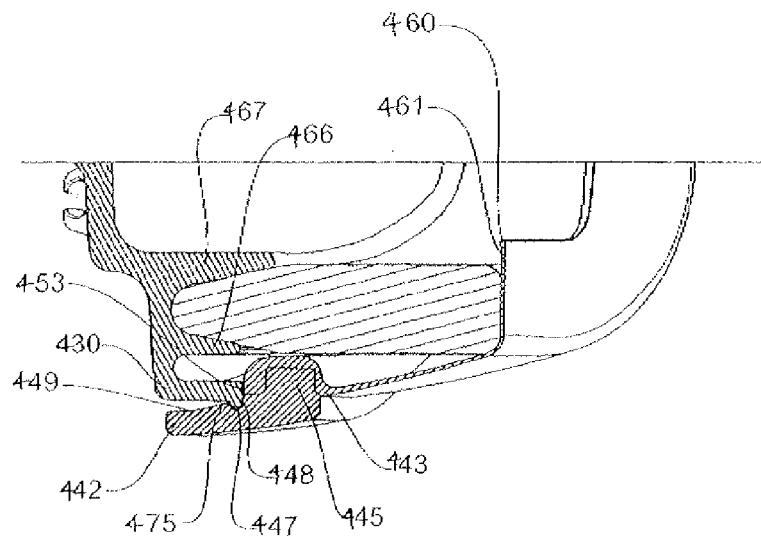


FIGURE 39A

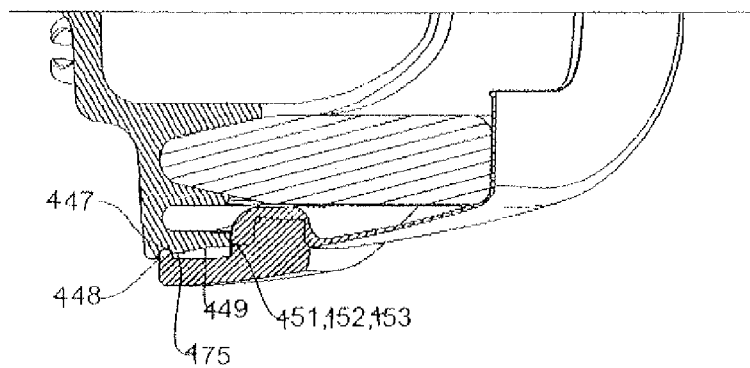


FIGURE 39B

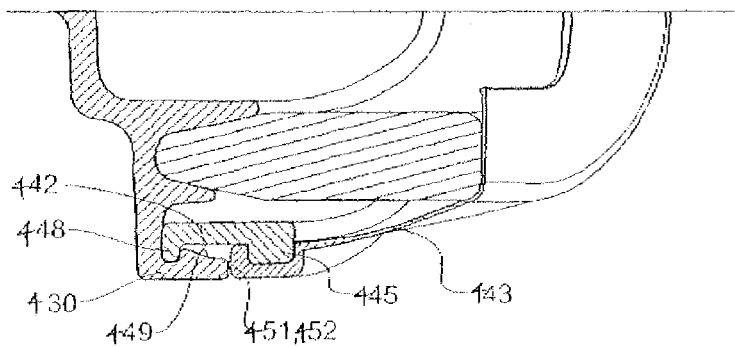


FIGURE 39C

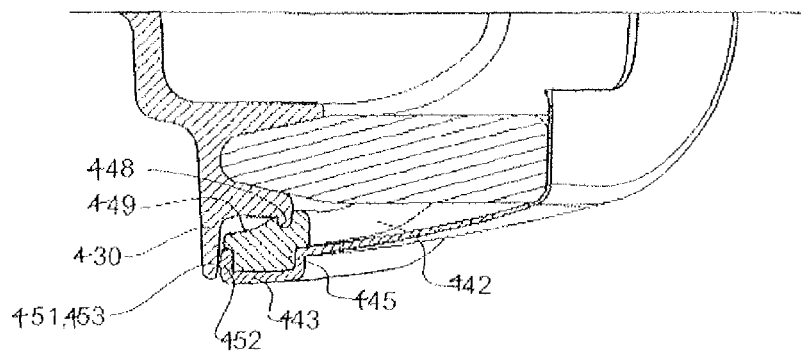


FIGURE 39D

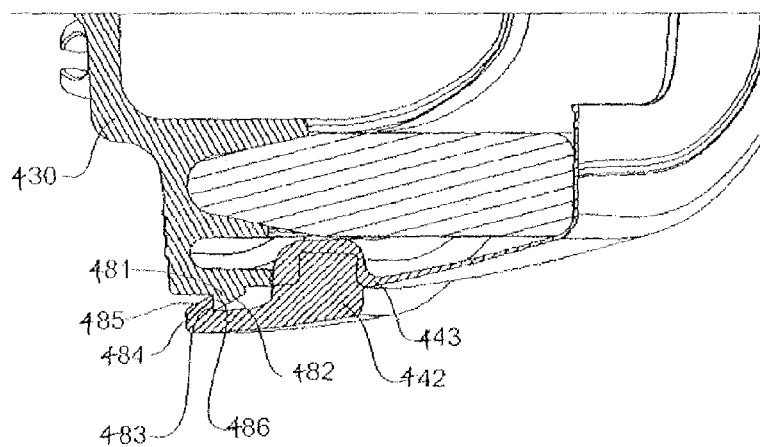


FIGURE 39E

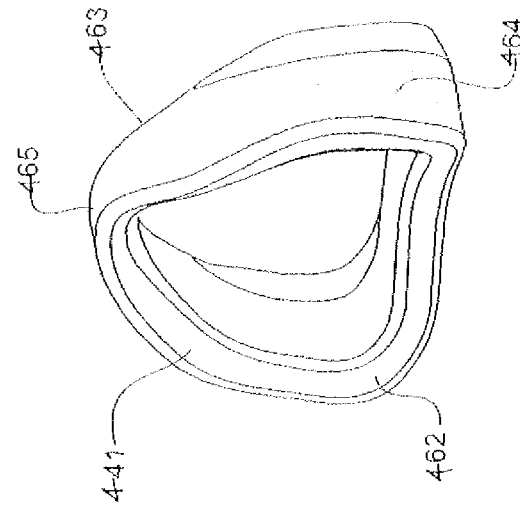


FIGURE 40B

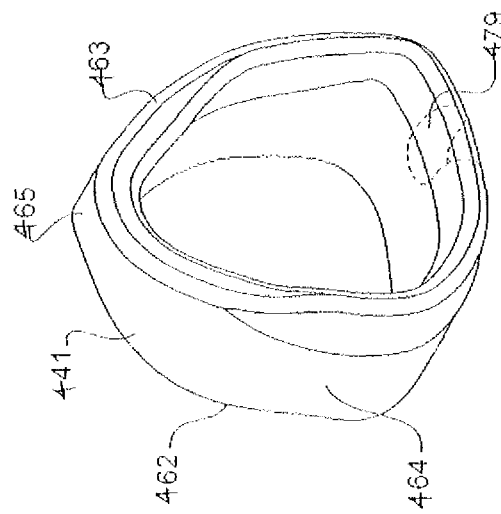


FIGURE 40A

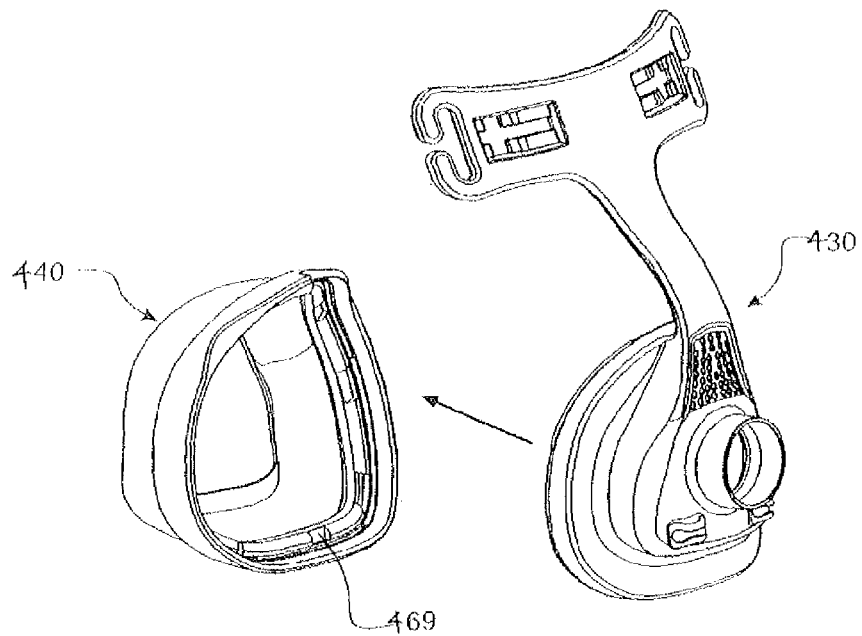


FIGURE 41A

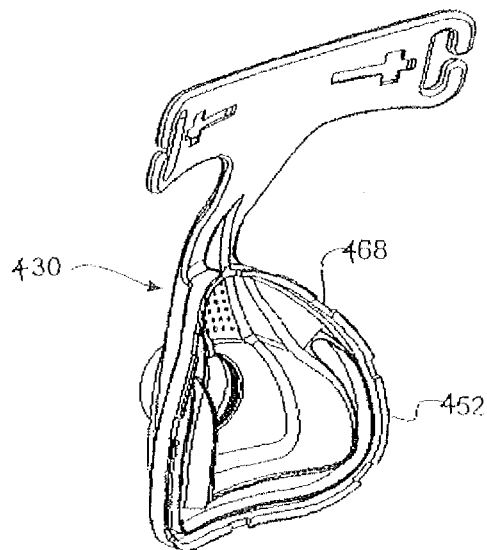


FIGURE 41B

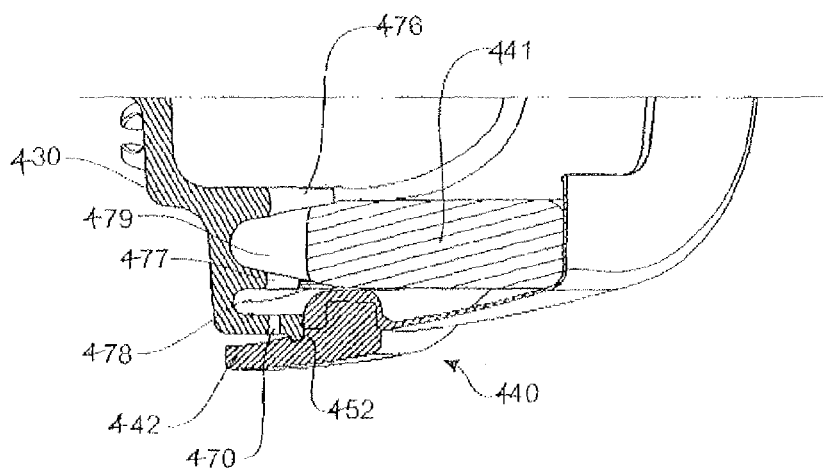


FIGURE 41C



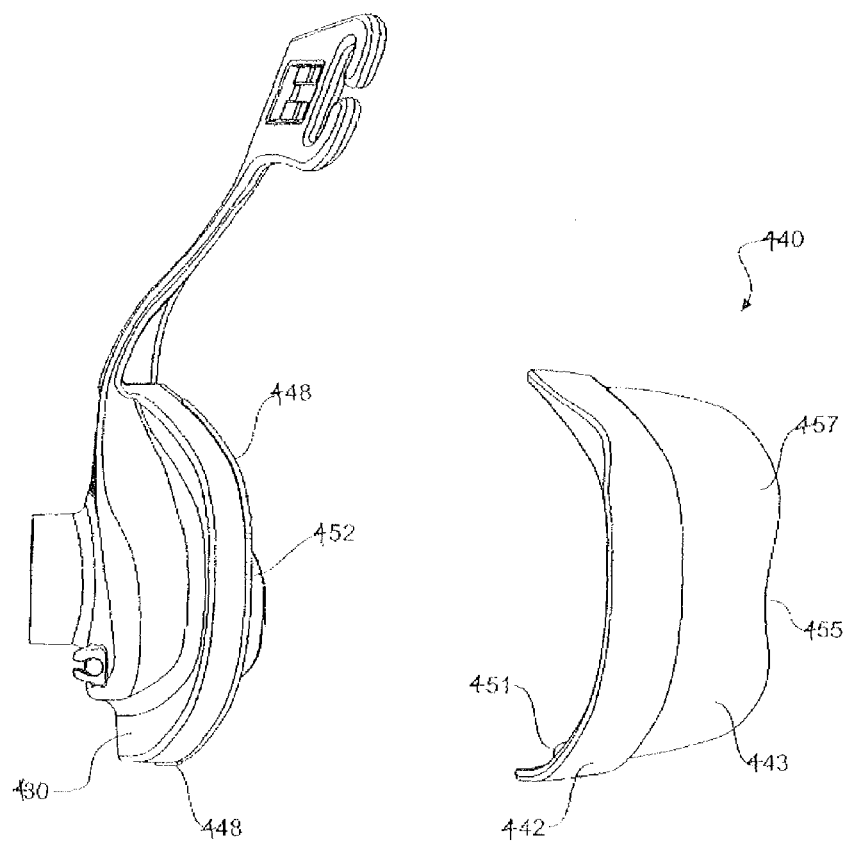


FIGURE 42

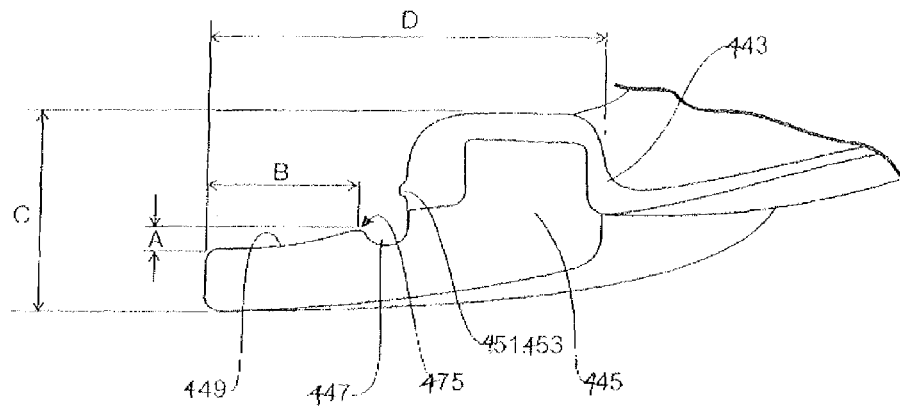


FIGURE 43

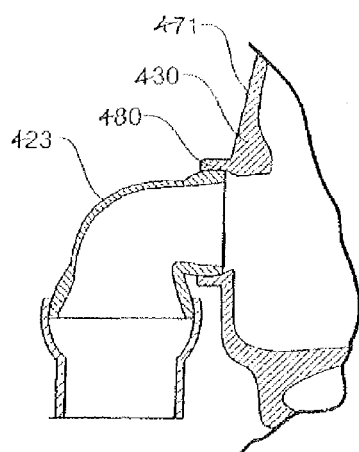


FIGURE 44A

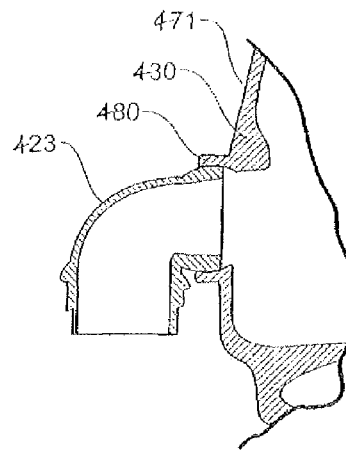


FIGURE 44B

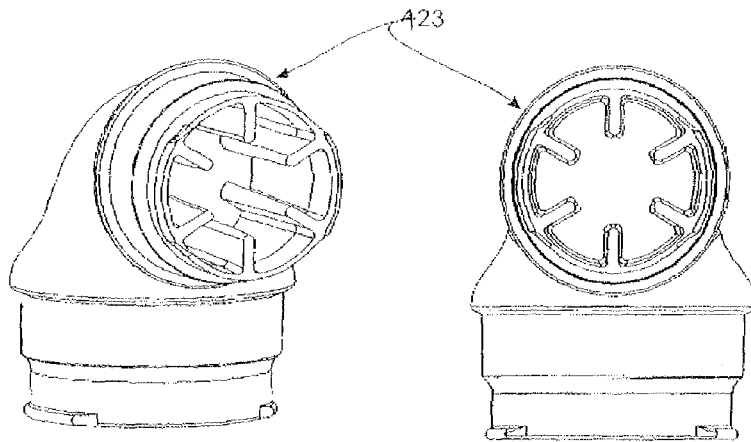


FIGURE 45A

FIGURE 45AA

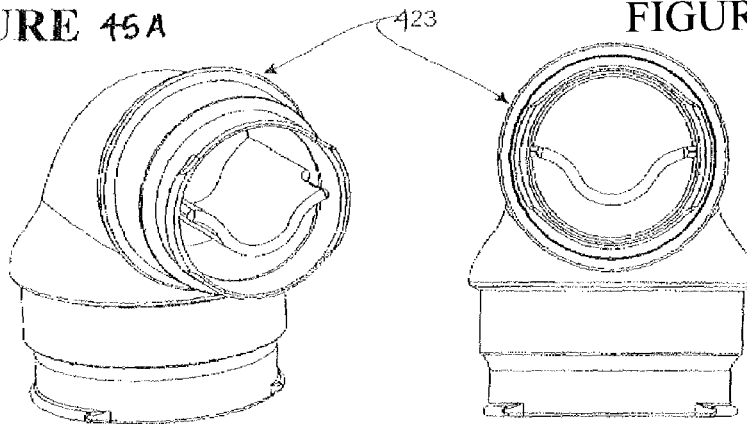


FIGURE 45B

FIGURE 45BB

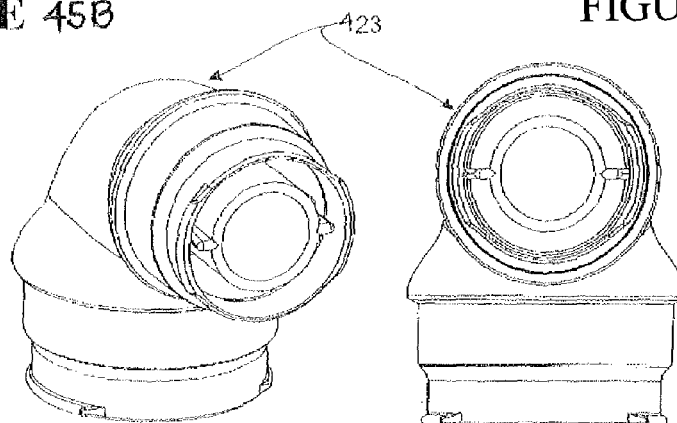


FIGURE 45C

FIGURE 45CC

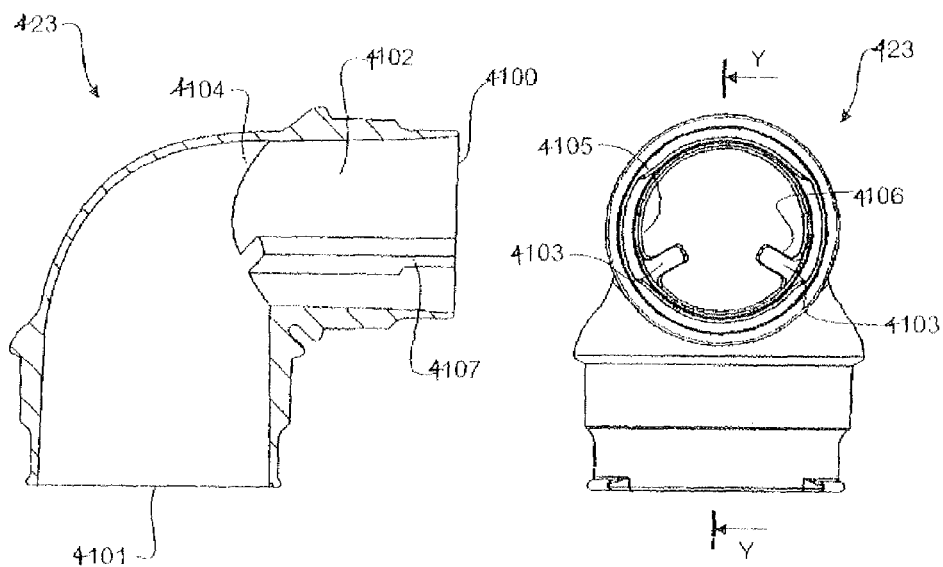


FIGURE 45D

FIGURE 45DD

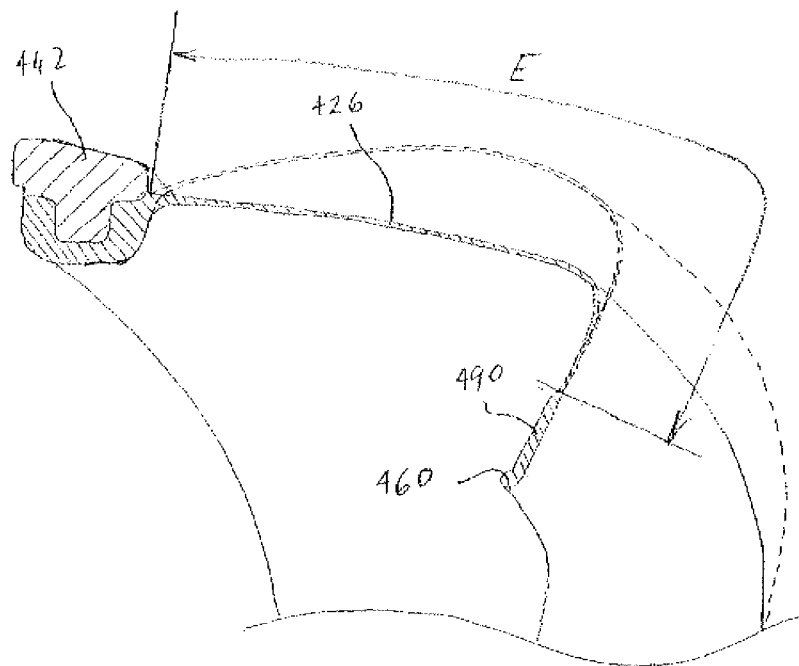


FIGURE 46

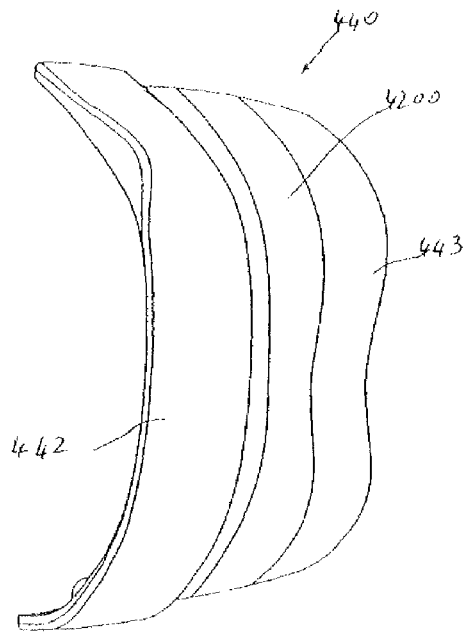


FIGURE 47A

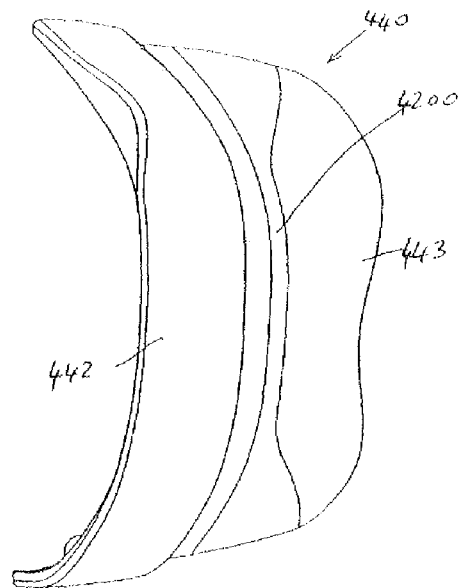


FIGURE 47B

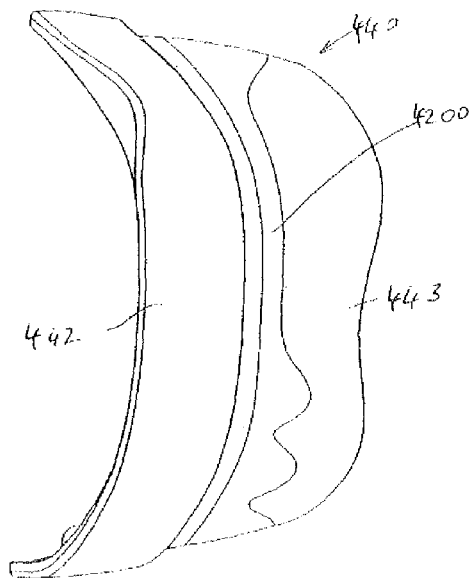


FIGURE 47C

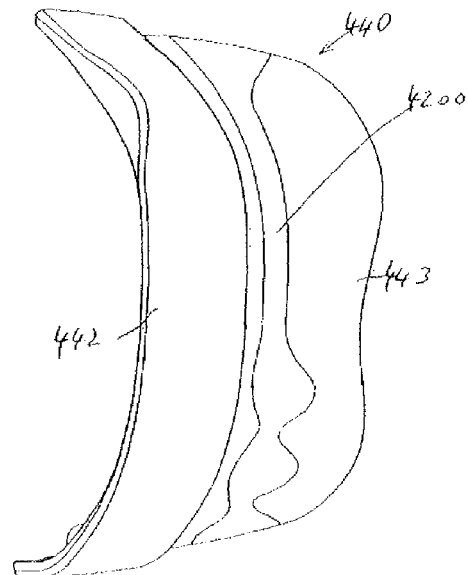


FIGURE 47D

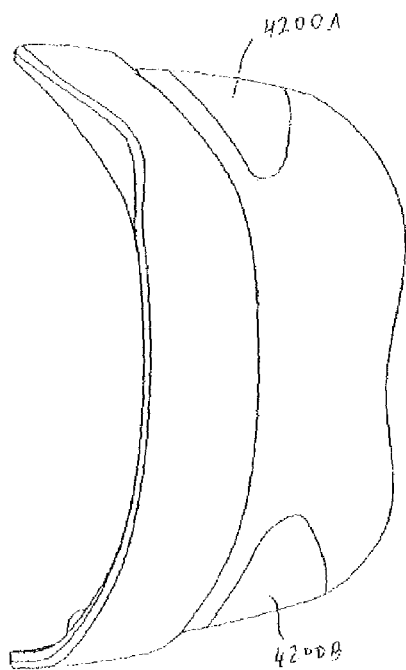


FIGURE 47E

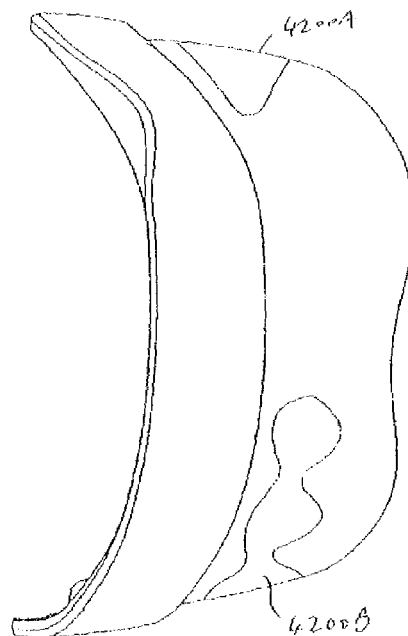


FIGURE 47F

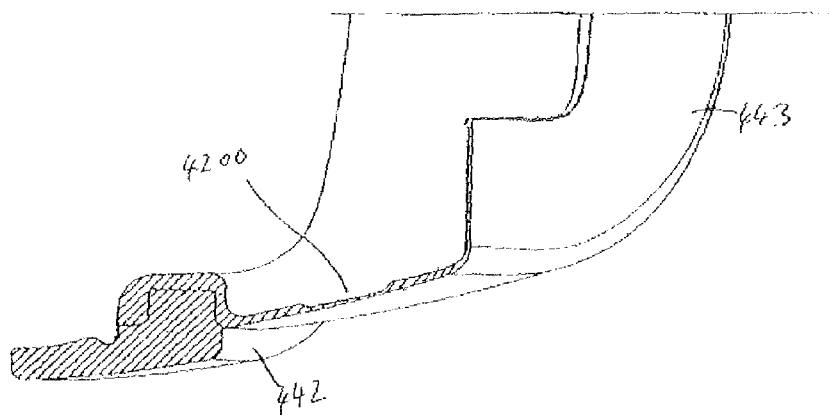


FIGURE 48

**BREATHING ASSISTANCE APPARATUS**

This application is a Continuation-In-Part application of U.S. patent application Ser. No. 10/599,394 which received a 371 filing date of Mar. 27, 2007, which is a 371 filing of PCT/NZ05/00062 filed on Mar. 30, 2005 and was published in English on Oct. 13, 2005 under International Publication Number WO 2005/094928 which claims the priority of New Zealand Patent Application No. 532108, filed on Apr. 2, 2004. This Continuation-In-Part application also claims the benefit of U.S. provisional application Ser. Nos. 61/082,007 filed on Jul. 18, 2008; 61/082,974 filed on Jul. 23, 2008; and 61/083,554 filed on Jul. 25, 2008. Each of these are hereby incorporated by reference in their entirety.

**BACKGROUND OF THE INVENTION****1. Field of the Invention**

This invention relates to patient interfaces particularly though not solely for use in delivering CPAP therapy to patients suffering from obstructive sleep apnoea (OSA).

**2. Summary of the Prior Art**

In the art of respiration devices, there are well known variety of respiratory masks which cover the nose and/or mouth of a human user in order to provide a continuous seal around the nasal and/or oral areas of the face such that gas may be provided at positive pressure within the mask for consumption by the user. The uses for such masks range from high altitude breathing (i.e. aviation applications) to mining and fire fighting applications, to various medical diagnostic and therapeutic applications.

One requisite of such respiratory masks has been that they provide an effective seal against the user's face to prevent leakage of the gas being supplied. Commonly, in prior mask configurations, a good mask-to-face seal has been attained in many instances only with considerable discomfort for the user. This problem is most crucial in those applications, especially medical applications, which require the user to wear such a mask continuously for hours or perhaps even days. In such situations, the user will not tolerate the mask for long durations and optimum therapeutic or diagnostic objectives thus will not be achieved, or will be achieved with great difficulty and considerable user discomfort.

U.S. Pat. Nos. 5,243,973 and 6,112,746 are examples of prior art attempts to improve the mask system. U.S. Pat. No. 5,570,689 and PCT publication No. WO 00/78384 are examples of attempts to improve the forehead rest.

Where such masks are used in respiratory therapy, in particular treatment of obstructive sleep apnea (OSA) using continuous positive airway pressure (CPAP) therapy, there is generally provided in the art a vent for washout of the bias flow or expired gases to the atmosphere. Such a vent may be provided for example, as part of the mask, or in the case of some respirators where a further conduit carries the expiratory gases, at the respirator. A further requisite of such masks is the washout of gas from the mask to ensure that carbon dioxide build up does not occur over the range of flow rates. In the typical flow rates in CPAP treatment, usually between 4 cm H<sub>2</sub>O to 20 cm H<sub>2</sub>O, prior art attempts at such vents have resulted in excessive noise causing irritation to the user and any bed partners.

In common with all attempts to improve the fit, sealing and user comfort is the need to avoid a concentrated flow of air at any portion of the respiratory tracts. In particular with oral masks or mouthpieces it is a disadvantage of prior art devices

that the oral cavity may become overly dehydrated by use of the device, causing irritation and possible later complications.

Furthermore, a common complaint of a user of CPA therapy is pressure sores caused by the mask about the nose and face and in particular in the nasal bridge region of the user.

In this specification where reference has been made to patent specifications, other external documents, or other sources of information, this is generally for the purpose of providing a context for discussing the features of the invention. Unless specifically stated otherwise, reference to such external documents is not to be construed as an admission that such documents, or such sources of information, in any jurisdiction, are prior art, or form part of the common general knowledge in the art.

**SUMMARY OF THE INVENTION**

It is an object of the present invention to attempt to provide a patient interface which goes some way to overcoming the abovementioned disadvantages in the prior art or which will at least provide the industry with a useful choice.

Accordingly in a first aspect the present invention consists in a mask assembly for use as part of an apparatus for supplying a flow of respiratory gases to a user comprising:

a mask body, said mask body including an inlet through which said flow of respiratory gases are provided to the interior of said mask body, the inlet adapted to in use be connected, to a gases conduit,

a mask seal assembly comprising a flexible seal and a rigid clip,

said seal having a first side and a second side, the first side of said seal being shaped to approximately match the contours of a user's face and in use substantially seal against a user's face, said second side adapted for attachment to said clip,

said clip being shaped to generally follow the contours of a user's face, and a rear periphery of said mask body also being correspondingly shaped to generally follow the contours of a user's face,

said clip providing a rigid interface extending substantially the full perimeter or periphery of the mask seal assembly for releasably attaching the mask seal assembly to the mask body,

one of the clip or the mask body having at least one recess and the other one of the mask body or the clip having a series of bumps, interference between the bumps and the clip or the mask body during attachment of the clip to the mask body providing a positive snap type engagement of the clip to the mask body as the bumps locate in the at least one recess, and one of the clip or the mask body having a lead in section providing a gradual deflection of the clip, or the mask body, or both, when attaching the clip to the mask body, the lead-in section extending substantially the full perimeter of the clip or the mask body.

Preferably the seal has a wall portion extending around the periphery of the seal assembly between the first and second sides, the wall being approximately or substantially constant in depth.

Preferably wherein the recesses are located immediately behind the lead-in section.

Preferably a cross section of the mask seal assembly at the clip has a width to height ratio of 1.5 to 2.

Preferably the clip is adapted to disengage the seal assembly from the mask body when squeezed at opposite perimeter portions at positions absent of a said bump.



3

Preferably the corresponding shape of the clip and the mask body provides for automatic correction of angular misalignment between the seal assembly and the mask body when fitting the seal assembly to the mask body.

Preferably the seal assembly attaches to the mask body in a sealed engagement, a first bearing surface of the seal bearing against: a corresponding second bearing surface of the mask body in a butting engagement.

Preferably the first bearing surface comprising a raised rim, in use the raised rim being compressed against the second bearing surface.

Preferably the clip has at least one wing portion, the wing portion providing a gripping flange to assist with removing the seal assembly from the mask body.

Preferably the lead-in section extends at least 50% of the full perimeter of the seal assembly clip or the mask body.

Preferably the mask assembly further comprises headgear for securing the mask assembly to the head of a user.

Preferably the mask assembly further comprises an inner cushion around the outer periphery of the mask body between the mask body and the first side of the sea).

The term "comprising" as used in this specification means "consisting at least in part of". Related terms such as "comprise" and "comprised" are to be interpreted in the same manner.

To those skilled in the art to which the invention relates, many changes in construction and widely differing embodiments and applications of the invention will suggest themselves without departing from the scope of the invention as defined, in the appended claims. The disclosures and the descriptions herein are purely illustrative and are not intended to be in any sense limiting.

The invention consists in the foregoing and also envisages constructions of which the following gives examples.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Preferred forms of the present invention will now be described with reference to the accompanying drawings.

FIG. 1 is a block diagram of a humidified continuous positive airway pressure (system) as might be used in conjunction with the sealing interface of the present invention.

FIG. 2 is an illustration of the nasal mask including a sealing interface in use according to the preferred embodiment of the present invention.

FIG. 3 shows a perspective view of a mask with a sealing interface that is a cushion.

FIG. 4 is a cutaway view of the mask showing the sealing interface cushion that has an inner sealing member and an outer sealing member.

FIG. 5 is a cutaway view of the periphery of the outer sealing member or membrane.

FIG. 6 is a cutaway view of the periphery of the mask body portion.

FIG. 7 shows a mask and sealing interface as used with a forehead rest on a patient.

FIG. 8 shows a cross section of a second preferred embodiment of the sealing interface.

FIG. 9 shows perspective view of an inner sealing member of the second preferred embodiment of the sealing interface.

FIG. 10 shows a cross section of a third preferred embodiment of the inner and outer sealing members of the present invention.

FIG. 11 shows a perspective view of the inner sealing member of the third preferred embodiment of the sealing interface.

4

FIG. 12 shows a plan view of the inner sealing member of the third preferred embodiment of the mask cushion.

FIG. 13 shows a cross section of a fourth preferred embodiment of the sealing interface of the present invention.

FIG. 14 shows a perspective view of the inner sealing member according to a fifth preferred embodiment of the sealing interface of the present invention.

FIG. 15 shows a cross section of a sixth preferred embodiment of the sealing interface of the present invention.

FIG. 16 shows a perspective view of the inner sealing member according to a seventh preferred embodiment of the sealing interface of the present invention.

FIG. 17 shows a perspective view of the inner sealing member according to an eighth preferred embodiment of the sealing interface of the present invention.

FIG. 18 shows a perspective view of the inner sealing member according to a ninth preferred embodiment of the sealing interface of the present invention.

FIG. 19 shows a perspective view of the inner sealing member according to a tenth preferred embodiment of the sealing interface of the present invention.

FIG. 20 shows across section of a further embodiment of the sealing interface of die present invention where the inner sealing foam member touches the outer sealing member at all times.

FIG. 21 is a side view of a nasal mask of the present invention where the outer sealing member is substantially thinner in width in the nasal bridge region than the rest of the outer sealing member.

FIG. 22 is a close-up view of detail A in FIG. 21.

FIG. 23 is a perspective view of the nasal mask of FIG. 21.

FIG. 24 is a cross-section of the outer sealing member of FIG. 21.

FIG. 25 is a front perspective view of a full face mask of the present invention, where the outer sealing member is substantially thinner in width in the nasal bridge region than the rest of the outer sealing member.

FIG. 26 is a back perspective view of a full face mask of FIG. 25.

FIG. 27 is a cross-section through BB of the full face mask of FIG. 25.

FIG. 28 is a perspective view of the outer sealing member of the full face mask of FIG. 25 in isolation, where the thin nasal bridge region is particularly shown.

FIG. 29 is a cross-section through CC of the outer sealing member of FIG. 28.

FIG. 30 is a front view of the outer sealing member of FIG. 28.

FIG. 31 is a front view of a first alternative outer sealing member.

FIG. 32 is a front view of a second alternative outer sealing member.

FIG. 33 is a front view of a third alternative outer sealing member.

FIG. 34 is a perspective view of a preferred embodiment of a patient interface.

FIG. 35 is an exploded view of the patient interface of FIG. 34, the patient interface comprising headgear, a mask seal assembly, a mask cushion and a mask body.

FIG. 36a is a perspective view of the mask seal assembly of the patient interface of FIG. 34 and FIG. 35, the mask seal assembly comprising a seal and a seal clip.

FIG. 36b is a perspective view of the seal clip of the mask seal assembly of FIG. 36a.

FIG. 37 is a perspective view showing the mask body and the mask seal assembly, with the mask seal assembly removed from the mask body.

FIG. 38 is a sectional view on line X-X of the patient interface of FIG. 34.

FIG. 39a is a part sectional view on line X-X showing a preferred form of the interface arrangement between the mask body and the mask seal assembly of the patient interface of FIG. 34.

FIG. 39b is a part sectional view showing a first alternative form of the interface arrangement between the mask body and the mask seal assembly.

FIG. 39c is a part sectional view showing a second alternative form of the interface arrangement between the mask body and the mask seal assembly.

FIG. 39d is a part sectional view showing a third alternative form of the interface arrangement between the mask body and the mask seal assembly.

FIG. 39e is a part sectional view showing a fourth alternative form of the interface arrangement between the mask body and the mask seal assembly.

FIGS. 40a and 40b are perspective views of the mask cushion of the patient interface of FIG. 34.

FIGS. 41a to 41c illustrate alternative arrangements for providing vent paths between the mask seal assembly and the mask body.

FIG. 42 is a side view of the mask body and the mask seal assembly of FIG. 34.

FIG. 43 is a part sectional view from the side showing tire clip and seal arrangement of the mask seal assembly of FIG. 34.

FIG. 44a and FIG. 44b are partial sectional views from tire side of preferred forms of connector for connecting a conduit, to the mask assembly.

FIGS. 45a and 45aa show a perspective view and a rear view of a first alternative form of connector for connecting a conduit to the mask assembly of FIG. 34, the connector incorporating radial baffles extending from the circumferential edge of the connector partway towards the centre.

FIGS. 45b and 45bb show a perspective view and a rear view of a second alternative form of connector for connecting a conduit to the mask assembly, the connector incorporating a single wave like baffle.

FIGS. 45c and 45cc show a perspective view and a rear view of a third alternative form of connector for connecting a conduit to the mask assembly, the connector incorporating a single circular baffle centrally located within the connector.

FIGS. 45d and 45dd show a cutaway side view and a rear view of a fourth alternative embodiment of connector for connecting a conduit to the mask assembly, the connector incorporating two radially aligned baffles.

FIG. 46 is a part sectional view of the mask seal assembly showing the seal in an un-pressurised state and a pressurised elastically stretched state.

FIGS. 47A to 47F show a side view of various mask seal assemblies each comprising a circumferential thin portion.

FIG. 48 is a cross sectional view of a seal assembly comprising a circumferential thin portion.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sealing interface of the present invention provides improvements in the delivery of CPAP therapy. In particular a patient interface is described which reduces the pressure of the mask on the patient's face and may be quieter for the patient to wear and reduces the side leakage as compared with the prior art. It will be appreciated that the patient interface as described in the preferred embodiment of the present invention can be used in respiratory care generally or with a ven-

tilator, but will now be described below with reference to use in a humidified CPAP system. It will also be appreciated that the present invention can be applied to any form of patient interface including, but not limited to, nasal masks, oral masks and mouthpieces.

With reference to FIG. 1 a humidified Continuous Positive Airway Pressure (CPAP) system is shown in which a patient 1 is receiving humidified and pressurised gases through a patient interface 2, 50 connected to a humidified gases transportation pathway or inspiratory conduit 3. It should be understood that delivery systems could also be VPAP (Variable Positive Airway Pressure) and BiPAP (Bi-level Positive Airway Pressure) or numerous other forms of respiratory therapy. Inspiratory conduit 3 is connected to the outlet 4 of a humidification chamber 5 that contains a volume of water 6. Inspiratory conduit 3 may contain heating means or heater wires (not shown) which heat the walls of the conduit to reduce condensation of humidified gases within the conduit. Humidification chamber 6 is preferably formed from a plastics material and may have a highly heat conductive base (for example an aluminium base) which is in direct contact with a heater plate 7 of humidifier 8. Humidifier 8 is provided with control means or electronic controller 9 which may comprise a microprocessor based controller executing computer software commands stored in associated memory.

Controller 9 receives input from sources such as user input means or dial 10 through which a user of the device may, for example, set a predetermined required value (preset value) of humidity or temperature of the gases supplied to patient 1. The controller may also receive input from other sources: for example temperature and/or flow velocity sensors 11 and 12 through connector 13 and heater plate temperature sensor 14. In response to the user set humidity or temperature value input via dial 10 and the other inputs, controller 9 determines when (or to what level) to energise heater plate 7 to heat the water 6 within humidification chamber 5. As the volume of water 6 within humidification chamber 5 is heated, water vapour begins to fill the volume of the chamber above the water's surface and is passed out of the humidification chamber 5 outlet 4 with the flow of gases (for example air) provided from a gases supply means or blower 15 which enters the chamber through inlet 16. Exhaled gases from the patient's mouth are passed directly to ambient surroundings in FIG. 1.

Blower 15 is provided with variable pressure regulating means or variable speed fan 21 which draws air or other gases through blower inlet 17. The speed of variable speed fan 21 is controlled by electronic controller 18 (or alternatively the function of controller 18 could be carried out by controller 9) in response to inputs from controller 9 and a user set predetermined required value (preset value) of pressure or fan speed via dial 19.

#### Nasal Mask

According to a first embodiment of the present invention the patient interface is shown in FIG. 2 as a nasal mask. The mask includes a hollow body 102 with an inlet 103 connected to the inspiratory conduit 3. The mask 2 is positioned around the nose of the patient 1 with the headgear 108 secured around the back of the head of the patient 1. The restraining force from the headgear 108 on the hollow body 102 and the forehead rest 106 ensures enough compressive force on the mask cushion 104, to provide an effective seal against the patient's face.

The hollow body 102 is constructed of a relatively inflexible material for example, polycarbonate plastic. Such a material would provide the requisite rigidity as well as being transparent and a relatively good insulator. The expiratory gases can be expelled through a valve (not shown) in the

mask, a further expiratory conduit (not shown), or any other such method as is known in the art.

#### Mask Cushion

Referring now to FIGS. 3 and 4 in particular, the mask cushion **1104** is provided around the periphery of the nasal mask **1102** to provide an effective seal onto the face of the patient to prevent leakage. The mask cushion **1104** is shaped to approximately follow the contours of a patient's face. The mask cushion **1104** will deform when pressure is applied by the headgear **2108** (see FIG. 7) to adapt to the individual contours of any particular patient, in particular, there is an indented section **1150** intended to fit over the bridge of the patient's nose as well as an indented section **1152** to seal around the section beneath the nose and above the upper lip.

In FIG. 4 we see that the mask cushion **1104** is composed of an inner sealing member that is an inner cushion **1110** covered by an outer sealing sheath or member **1112**. The inner cushion **1110** is constructed of a resilient material for example polyurethane foam, to distribute the pressure evenly along the sea) around the patient's face. In other forms the inner cushion **1110** may be formed of other appropriate material, such as silicone or other composite materials. The inner cushion **1110** is located around the outer periphery **1114** of the open face **1116** of the hollow body **1102**. Similarly the outer sheath **1112** may be commonly attached at its base **1113** to the periphery **1114** and loosely covers over the top of the inner cushion **1110**.

In the preferred embodiment of the present invention as shown in FIGS. 4 to 6 the bottom of the inner cushion **1110** fits into a generally triangular cavity **1154** in the hollow body **1102**. The cavity **1154** is formed from a flange **1156** running mid-way around the interior of the hollow body.

The outer sheath **1112** fits in place over the cushion **1110**, holding it in place. The sheath **1112** is secured by a snap-fit to the periphery **1114** of the hollow body. In FIGS. 5 to 6 the periphery **1114** is shown including an outer bead **1158**. The sheath **1112** includes a matching bead **1159**, whereby once stretched around the periphery; the two beads engage to hold the sheath in place.

A second preferred embodiment to the mask cushion is depicted in FIGS. 9 and 10. In the second embodiment the inner cushion **2000** includes a raised bridge **2002** in the nasal bridge region. The raised bridge **2002** can also be described as a cut out section made in the cushion. Also, the notch in the contacting portion (between the inner cushion and outer sheath) is less pronounced than, proceeding embodiments. However, as the raised bridge **2002** is unsupported it is much more flexible and results in less pressure on the nasal bridge of the patient. The outer sheath **2004** contacts the inner cushion **2000** throughout the raised bridge **2002**. The peaks **2005**, **2007**, **2009**, **2011** in the inner cushion **2000** between each of the indented sections **2006**, **2008** and the raised bridge **2002** contact the outer sheath **2004** and when in use the sheath **2004** contacts the facial contours of the patient in the regions of these peaks.

Referring particularly to FIG. 10 the inner cushion **2000** includes a cheek contour **2006** to follow the cartilage extending from the middle of the nose, and a contoured lip sealing portion **2008** to seal between the base of the nose and the upper lip.

Referring now to FIGS. 11 and 12 a third preferred embodiment of the mask cushion is depicted, in this case, the inner cushion **2010** tapers down **2012** towards the nasal bridge region **2014**. For a short portion either side of the nasal bridge region **2014** the inner cushion **2010** is absent, forming a semi annular form in plan view as seen in FIG. 12.

Referring to FIG. 13, a fourth preferred embodiment of the mask cushion is depicted. The outer sheath **2020** is adapted to contact the inner cushion **2022** completely about the inner cushion, including in the nasal bridge region **2024** and the cheek contour **2026**. FIG. 18 shows the inner cushion **2022** where the upper edge **2050** of the cushion does not have any contours and thus will contact the outer sheath all around the edge of the inner cushion. FIG. 20 shows a sealing interface similar to that of FIG. 13 where the inner cushion also follows and touches the outer sheath all around its edge.

FIG. 14 illustrates a fifth preferred embodiment of the inner cushion **2030**. In the nasal bridge region **2032** the inner cushion includes a lower bridge **2034** and upper bridge **2036**. Due to the gap the upper bridge **2036** is unsupported to reduce pressure on the patient's nasal bridge, but the lower rim **2034** of the inner cushion **2030** is continuous, which aids installation.

In yet other forms of the sealing interface of the present invention the inner cushion may be provided with other contours on the front side of the inner cushion or cut outs on the back side of the inner cushion, so that in the areas where there are regions cutout of the back side of the cushion the cushion is more flexible. In particular, cut outs in the nasal bridge, cheek and upper lip regions provide the patient with a mask cushion that is more flexible and thus more comfortable. FIG. 15 shows an embodiment of an inner cushion **2024** that has a curved cut out or dead space **2044** in the cheek region. FIGS. 16 and 17 show embodiments of an inner cushion **2000** that has a cut out or dead space **2046** in the area where the patient's upper lip rests in the foam.

A final form of a sealing interface is shown in FIG. 19, here the inner foam member has an annular shape but has a thin bridge or membrane **2048** that, extends across and provides flexibility to the nasal bridge region.

Referring now to FIG. 21, to improve the comfort to the patient the nasal mask **200** includes a thin bridge section **203** in the nasal bridge region of the outer sealing member **201**, that is, that part extending over the bridge of a patient's nose.

Similar to that described above the outer sealing member or outer sheath **201** fits in place over the inner sealing member (inner cushion) **202**, holding it in place. The outer sheath **201** is secured by a snap-fit to the periphery **205** of the mask hollow body **204**. The periphery **205** is shown including an outer bead **206**. The outer sheath **201** includes a matching bead **207**, whereby once stretched around the periphery **205**; the two beads engage to hold the outer sheath **201** in place.

The outer sealing member or sheath **201** is shown in more detail in FIGS. 22 to 24. The outer sheath **201** has formed in it a region **203** that is thinner than the remainder of the cross-sectional thickness **210** of the sheath. In particular, the side walls **211**, **212** (see FIG. 23) must be thicker than in the region **203** so as to provide structural support for the sheath and ensure the sheath does not collapse in use, or when being assembled with the mask body. As an example only, for a nasal mask, if the thin bridge region was 0.2 mm thick, the side walls may be 0.3 to 0.6 mm thick. Therefore, the thin bridge region **203** is approximately half the thickness of the rest of the sheath **201** and so can provide a significant effect, such that the pressure to the patient's nose in the nasal bridge region is reduced compared to when a sheath does not have any reduced thickness section. Furthermore, a thin bridge region **203** in the outer sheath **201** allows for different sized patient's to comfortably use the mask and outer sheath of the present invention.

In use, when a force is placed against the outer sheath **201** the thin bridge region **203** will collapse more than the rest of

the outer sheath **201**. Therefore, this section **203** is more flexible and allows for added patient comfort.

Referring particularly to FIG. **22**, the thin bridge region **203** on the outer sheath **201** preferably does not extend completely to the outer edge **211** of the outer sheath **201**, but grows thicker in thickness. This is because the outer edges of the outer sheath **201** when thicker are less prone to tearing.

In particular, in FIG. **23**, that outer sheath **201** is substantially heart shaped and the thin bridge region **203** is shown to extend more than halfway down the sides of the sheath from the apex **213**. As shown in FIG. **23**, the thin bridge region **203** does not extend fully down the edges **211** and **212** of the outer sheath **201**. This is because support is required in the edges of the sheath **201**, to provide structural stability of the sheath.

In other forms of the nasal mask of the present invention, the thin bridge region may not extend as far as that shown in FIG. **23**, but be restricted merely to the nasal bridge region (similar in manner to the mask cushion shown in FIG. **30**, in relation to a full face mask).

#### Full Face Mask

A further embodiment of the present invention is shown in FIGS. **25** to **31** where the patient interface is a full face mask similar to that described in co-pending New Zealand patent application number 528029. The full face mask **300** includes a hollow body **302** and outer sealing member or mask cushion **301**. The cushion **301** is attached to the body **302** in a similar manner as described with reference to the nasal mask, but here no inner cushion is provided. Thus, the cushion **303** periphery extends over a flange on the mask body.

The hollow body **302** has an integrally formed recess (not shown) in which an insert **304** is fitted into. The recess and insert **304** each have complimentary circular apertures (generally indicated as **305**) that form an inspiratory inlet when the insert **304** is placed in the recess. The inlet **304** is capable of being connected to the tubing that forms the inspiratory conduit **3** (as shown on FIG. **1**). Oases, supplied to the inspiratory conduit **3** from the CPAP device and humidifier, enter the mask through the apertures **305** and the patient is able to breathe these gases. The mask **300** is positioned around the nose and mouth of the patient and headgear (not shown) may be secured around the back of the head of the patient to assist in the maintaining of the mask on the patient's face. The restraining force from the headgear on the hollow body **302** ensures enough compressive force on the mask cushion **301** to provide an effective seal against the patient's face.

The hollow body **302** and insert **304** are injection moulded in a relatively inflexible material, for example, polycarbonate plastic. Such a material would provide the requisite rigidity for the mask as well as being transparent and a relatively good insulator. The mask cushion **301** is preferably made of a soft plastics material, such as silicone, KRATON™ or similar materials.

The cushion **301** of the mask **300** includes a thin bridge section **305** in the nasal bridge region of the cushion **301** that is, that part extending over the bridge of a patient's nose. As an example, in the region of the thin bridge section **305** the walls of the cushion may be 0.2 to 0.3 mm thick and the rest of the cushion may have a thickness of 1 mm. In particular, the side walls need to be thicker to provide support in the cushion, so that it does not collapse during use or assembly with the mask body. In FIG. **29**, this is particularly illustrated, as the section **305** in the nasal bridge region is shown as being much thinner than the rest of the cushion (in particular the bottom side wall region **306**, which are much thicker in cross-section).

Note must be made that the inner flange **307** of the cushion **301** that rests against the patient's face is also thinner in

section than the side walls of the cushion **301** to provide flexibility to the cushion and thus comfort to the patient. In use the inner flange **307** is the area of the cushion that seals against the patient's face and the side walls of the cushion provide stability to the cushion **301**.

In use, when a force is placed against the cushion **301** the thin bridge section **305** will collapse more than the rest of the cushion **301**. Therefore, this section **305** is more flexible and allows for added patient comfort.

Other forms of the cushion that may be used with the full face mask of the present invention are shown in FIGS. **31** to **33** and each show alternative thin sections that may be provided for patient comfort, and to allow for fitting to different sized patients.

Referring first to FIG. **31**, cushion **310** may have a thin bridge section **313** that is narrower than that shown in FIG. **30**.

In FIG. **32** the cushion **312** has a thin bridge section **313** only near the outer edge **317** of the cushion **312**. This cushion **312** also had a thin section **314** in the region of the cushion that would rest against the patient's chin.

Finally, in FIG. **33**, the thin section **316** of the cushion **315** may extend down the sides **318**, **319** of the cushion.

#### Forehead Rest

The nasal mask and/or full face, mask of the present invention is preferably provided with a fixed forehead rest (**208**, as shown in relation to the nasal mask in FIGS. **21** and **23** or **303**, as shown in relation to the full face mask in FIG. **25**). The forehead rest is not required to be adjustable as the cut out in the nasal bridge region of the inner foam (for the nasal mask) and the thin section in the outer sheath (for both the nasal and full face masks) provides enough flexibility of the mask cushion to provide fitting to a number of different patients.

#### Improved Patient Interface

A further preferred embodiment of the present invention is patient interface **50** described with reference to FIG. **34** and FIG. **35**. The patient interface **50** includes a mask assembly **402** and headgear **421**.

#### Headgear

Headgear **421** is worn by the user in use, and holds the mask assembly **402** in the required position on the user's face. The headgear **421** in the preferred form is comprised of headgear straps **435**, **436**, **437**, **438**, and an elongate glider member **434**. The elongate glider member extends across the front of the mask assembly **402** and attaches to the mask body **430** of the mask assembly **402** via at least one clip type fitting **433**. The elongate member **434** may slide, or glide, within the clip type fitting **433** so that the mask assembly **402** may move laterally with respect to the head gear. This arrangement for attaching the headgear to the mask assembly is the preferred arrangement. Other arrangements may also be used, such as a fixed or static arrangement.

Each end of the elongate glider member may include a hook **432** to which each end of headgear strap **435** may releasably attach. Alternatively, headgear strap **435** may attach directly to the mask body **430**.

In the preferred form, the mask assembly **402** includes a forehead support **431**. The forehead support, is attached to the mask body **430** by a vertical support member **429**, the forehead, support and vertical support member together forming a T shape. The forehead support **431**, vertical support member **429** and mask body **430** may be integrally formed as a single piece.

Alternatively, the forehead support may be adjustable in a vertical direction, or may be pivotably attached to the mask body **430**.

One end of headgear strap **436** may attach to a first end of the forehead support, and the opposite end of headgear strap

## 11

436 may attach to a second end of the forehead support 431. The forehead support may include at least one support pad or cushion 428. In use, the forehead support locates against the user's forehead and provides stability to the nasal interface 50 when fitted, to the user.

Headgear straps 437 and 438 extend substantially vertically between headgear straps 435 and 436. Headgear straps 437 and 438 provide support to straps 435 and 436, positioning straps 435 and 436 a set distance apart around the user's head.

The headgear straps are preferably made from a laminated sheet of open cell foam sandwiched between two sheets of textile fabric.

It should be noted that many equivalent forms of head gear known in the art may be suitable for use with the mask assembly 402. What has been described above is the preferred form.

## Mask Body

The mask assembly 402 of FIGS. 34 and 35 comprises a mask body 430 and a mask seal assembly 440.

The mask body 430 provides the overall structural support for the mask assembly, and provides at least one clip type fitting for attaching the mask assembly 402 to the headgear 421.

A rear side of the mask body 30 interfaces to the seal assembly 440, the seal assembly 440 providing a sealing interface against a user's face in use. The rear side of the mask body 430 is the side that faces towards a user, when the user has the mask assembly 402 in place on their face. The mask body 430 has an inlet for receiving a flow of respiratory gases. The mask body forms an internal cavity to which respiratory gases are supplied via the inlet from the CPAP system. The inlet comprises a tubular projection 422 extending from a front side 471 of the mask body 430. The front side 471 of the mask body 430 is the side that faces away from a user, when the user has the mask assembly 402 in place on their face.

## Connector

A first end of connector 423 connects to the mask body tubular projection 422. The interface between the tubular projection 422 and the connector 423 preferably allows the connector 423 to swivel with respect to the mask body 430.

Alternatively, as shown in FIGS. 44a and 44b, the inlet may comprise a semi-tubular projection 480 extending from the front side 471 of the mask body. The semi-tubular projection forms a socket for receiving a correspondingly shaped first end of the connector 423. In use, the first end of the connector and the semi-tubular projection form a ball joint allowing the connector 423 to swivel and pivot within the socket, relative to the mask body 430. In alternative embodiments the mask body 430 may not include a projection, and the inner surface of the mask body 430 may be curved to form a socket for receiving the connector. In other alternative forms, other types of connection may be utilised between, the mask body and the connector, such as a flexible piece of silicone, or other appropriate connection mechanism.

The connector 423 is preferably an elbow connector having a first leg a bend and a second leg. The bend is preferably a substantially 90 degree bend.

A second end of the connector connects to the inspiratory 5 conduit 3, either directly to the conduit 3, or via a second connector 424. The interface between the elbow connector 423 and the conduit 3 or the second connector 424 preferably allows the conduit 3 to swivel with respect to the connector 423.

Alternatively, the interface between the second end of the connector and the conduit 3 may comprise a ball joint that

## 12

allows the second end of the connector to swivel and pivot relative to the conduit, as shown in FIG. 44A.

Preferably the connection between the mask body 430 and the conduit 3 can be flexed or rotated to allow for the conduit to be moved without causing the dislodgement of the mask assembly 402 from the user's face. This is a preferred feature, but is not essential.

As best shown in FIG. 35, the preferred form of elbow connector 423 is a substantially right angle connector with the tubular inlet projection 422 aligned substantially perpendicular to the front of the mask body 430. Other alternative arrangements may be incorporated in the mask assembly of the present invention. For example, the connector may be a straight connector, with any necessary bend accommodated by the conduit 3. Alternatively, the tubular inlet projection may extend from the front of the mask body at an angle, for example angling downwards, with the connector having a corresponding obtuse angle.

Preferably the connector 423 may be easily removed from the mask body by pulling the connector 423 away from the mask body 430.

## Reducing Diameter Connector

As shown in FIG. 35, in the preferred form, the first end 4100 of the elbow connector 423, interfacing with the mask body 430, is smaller in diameter than the second end 4101 of the elbow connector. Preferably the diameter of the connector 423 reduces around the length of the bend in the connector 423, from the full diameter at the second or outer end, to the reduced diameter at the first or inner end. As an example, the diameter of the inspiratory conduit commonly used in the art is approximately 25 mm. Prior art masks continue this full diameter through to the mask body interface. In the preferred form, the diameter of the connector 423 at the mask body interface is reduced to approximately 20 mm.

It is desirable to have a mask assembly that is as small and lightweight as possible, while at the same time providing an effective seal against a user's face. The reducing diameter of the connector 423 helps to make the mask assembly lightweight and small. The reducing diameter of the connector 423 helps to visually give the mask assembly a small, compact look.

One problem with a connector 423 having a reducing diameter connector is that air flow through the connector can become unacceptably noisy. Noise is created as the air flow passes through the reducing cross section of the connector. It is thought that this noise is created by an increase in the speed and turbulence of the flow of inspiratory gases through the reduced cross section portion 4102 of the connector 423. The additional noise level is clearly undesirable as it can disturb the user's sleep, or the sleep of a user's partner.

To overcome the problem of increased noise levels, the connector 423 of the preferred embodiment includes at least one baffle 4103 located in the reduced cross section portion of connector 423.

FIGS. 45a and 45aa show a first alternative form of the connector 423, including six equally spaced baffles 4103, each baffle extending from a first end 4100 of the reduced cross section portion 4102 of connector 423 to a second end 4104 of the reduced cross section portion of connector 423. The introduction of the baffles significantly reduces the noise create by the reduced cross section portion.

A downside to introducing the baffles is a higher pressure drop through the connector 423. It has been determined by the inventors following extensive research that a significant reduction in noise level is achieved by incorporating two baffles only, the baffles located at the third and fifth positions when considering six equally spaced positions spaced from

top-dead-centre around the circumference of the reduced cross section portion of connector **423**, top-dead-centre being position **1**, with the second leg of the elbow at the downwards fourth, or 6 o'clock, position. This arrangement is shown as a fourth alternative embodiment in FIGS. **45d** and **45dd**.

The noise reduction achieved by incorporation of two baffles only in the positions described is similar to the noise reduction achieved with incorporation of all six baffles. The introduction of two baffles in the third and fifth positions results in a significant reduction in noise levels, a similar result to the introduction of six baffles as shown in FIGS. **45a** and **45aa**. However, the pressure drop in the flow of gases through the connector **423** due to the incorporation of two baffles is lower than the pressure drop with six baffles. The most preferred form of baffle arrangement is therefore to include two baffles, located at the positions described, resulting in an acceptable compromise between acceptable noise levels and acceptable resistance to flow through the connector **423**. The fourth alternative embodiment, which shows the most preferred form of baffle arrangement, is shown in FIGS. **45d** and **45dd**. The baffles are preferably aligned radially within the reduced cross section portion of connector **423**.

In the preferred embodiment the baffles connect to the circumferential wall **4105** of connector **423**. The baffles extend along the wall **4105** substantially parallel to a longitudinal axis of the reduced portion **4102**. Preferably the baffles extend from the second end **4104** of the reduced diameter portion to the first end **4100** of the reduced portion. Alternatively, the baffles may extend part way along the reduced diameter portion. Preferably the baffles extend along the full length of the reduced diameter portion **4102** and connect along the wall **4105**, along the full length of the baffle except for an end portion **4107** near the first end **4100** of the connector **423**, the end portion **4107** of each baffle **4103** being detached from the side wall **4105**. The end portion **4307** of each baffle **4103** is not connected to the wall **4105** of the connector **423** so that additional strength provided by the baffles is not applied to the connector wall at the first end **4100**. This allows the wall **4105** at the first, end **4100** to deflect more easily when connecting connector **423** to the mask body **430**.

The baffles are around 1.5 mm thick and around 3 mm in radial height from the side wall **4105**. The thickness of the baffle is not overly important for achieving a reduction in noise level. The thickness dimension is chosen to allow ease of manufacturing. The connector **423** is typically manufactured by plastic injection moulding. Other injection moulding techniques may be incorporated for ease of manufacture, such as (halting the internal bore of the connector and drafting the baffles. Preferably the sides **4106** of the baffles **4103** have a draft of around 0.5°. The edge **4107** of the baffles **4103** have the same draft as the internal diameter of the reduced diameter portion **4102**, that is, a draft of around 1° to 1.5°.

Further research found that the radial height of the baffles had a significant effect on the reduction in noise levels. A significant reduction in noise level was obtained with a baffle radial height of 3 mm. There was a large improvement in noise reduction by increasing the radial height from 2 mm to 3 mm. However, the improvement achieved by increasing the radial height from 3 mm to 4 mm was not as significant.

In an alternative embodiment the baffles **4103** may be connected to form a continuous bridge across the cross section of the reduced diameter portion **4102**. However, for performance and ease of manufacture this is not a preferred embodiment.

Alternative baffle arrangements have also been found to be useful in reducing noise levels of gases flow through connec-

tor **423**. FIGS. **45b** and **45bb** show a single baffle that extends across the reduced cross sectional area of the connector, the baffle being curved to extend towards the side nearest the elbow bend of connector **423**, that is, the side opposite top-dead-centre with the second leg in the downward 6 o'clock position. FIGS. **45c** and **45cc** show a single circular baffle located centrally within the reduced cross section portion of connector **423**, the circular baffle being supported by extensions at the six and three o'clock positions connecting between the outer wall of the single circular baffle and the inner wall of the connector. However, based on testing carried out by the inventors, these alternative embodiments are not the most preferred forms.

The use of baffles may also be helpful in reducing noise levels in an elbow connector with equal diameter legs, as turbulence in the gases flow is caused by flow around the bend of the elbow.

Alternatively, the use of baffles may also be helpful in reducing noise levels caused by a gases flow through a reducing diameter connector that has a straight through bore.

Mask Seal Assembly and Mask Seat Assembly to Mask Body Interface

Preferred and alternative forms of the mask body **430** and a mask seal assembly **440** shall now be described with reference to FIG. **36-43**.

In the preferred form, the seal assembly **440** comprises a flexible seal **443** attached to a relatively rigid plastic clip **442**, as shown in FIG. **36a**. Preferably the flexible seal **443** is permanently attached to the plastic clip **442** so that the seal assembly **440** forms a single, item of the mask assembly **402**.

In the preferred form, the seal **443** is over-moulded to the plastic clip **442**. The plastic clip has a series of holes **446** around its perimeter. During manufacture, over moulding of the seal to the clip causes the seal material to flow through the series of holes **446**. During manufacture, the seal material is cured. Once cured, the seal **443** is mechanically linked to the plastic clip **442** via holes **446**, providing a mechanical joint between the clip and the seal. In the preferred embodiment, the holes **446** are located through a raised ridge **445** running around the inside perimeter of the clip. Preferably the raised ridge **445** and holes **446** are located on a inside surface of the clip, so that the mechanical bond is located on the inside of the clip, with the joint between the clip **442** and the seal **443** visible as a simple butt joint on the outside surface of the seal assembly **440**.

In alternative embodiments, the raised ridge **445** may be located on the outside perimeter of the clip, as shown in FIGS. **39c** and **39d**.

Alternatively, the seal **443** may be chemically bonded to the plastic clip. Chemical bonding may be used in combination with the mechanical bond described above.

Alternatively, the seal **443** could be glued to the plastic clip **442** with an appropriate adhesive, or the seal could be mechanically fixed to the clip. For example the seal could be sandwiched between the clip and a flange, with screws or other mechanical fixings securing clip and the flange together, with the seal sandwiched in between. This type of mechanical fixing could be permanent, or the fixings, such as screws, may allow the seal to be dismantled from the plastic clip.

Alternatively, the seal **443** could be assembled to the clip **442** in a press fit arrangement. The press fit may allow the seal **443** to be attached to and detached from the seal clip **442** many times. Alternatively, the press fit may be a permanent connection of the seal **443** to the clip **442**.

The clip **442** forms a rigid perimeter for the seal assembly **440**, the clip **442** being rigid relative to the seal **443**. The clip

15

provides a rigid interface extending the full perimeter of the seal assembly or at least substantially the full perimeter of the seal assembly.

The interface between the rigid clip **442** and the rigid mask body **430** provides a positive engagement between the seal assembly **440** and the mask body **430**. This positive engagement provides an improvement over prior art masks that have a flexible seal interfacing directly to a mask body. The face seal assembly of the present invention may be easily and quickly assembled and disassembled to and from the mask body in a single engagement action. A flexible seal to mask body interface requires a comparatively more difficult seal to body engagement, as discrete portions of the seal must be fitted one at a time to the mask.

Preferably the seal assembly clip **442** and mask body **430** are made from polycarbonate, nylon, acetyl or other similar rigid plastic.

Alternatively, the seal assembly clip **442** and mask body **430** could be made from a semi-rigid material such as a thermoplastic elastomer, silicone rubber or urethane, or other similar semi-rigid material. Preferably the semi-rigid material has a Shore-A hardness of 60 or higher.

The clip **442** is shaped to match the shape of the back perimeter region **452** of the mask body **430**. The clip **442** may only be attached to the mask body in a single orientation. It is therefore not possible to attach the seal assembly **440** to the mask body **430** incorrectly.

The clip **442** attaches to the mask body in a 'clip' or 'snap' type engagement. A series of blimps **448**, or raised portions, on the mask body **430** interact with corresponding recesses **447** on the clip **442**, to hold the clip **442** in place on the body **430**. For example, for a mask that has a substantially equilateral perimeter with three sides, three recesses **447** may be located on the inside surface of the clip, the recesses being spaced apart, one recess being located on each side of the equilateral perimeter. The mask body, being correspondingly shaped to match the seal assembly clip, has three corresponding bumps **448**. As the clip **442** attaches to the mask body, interference between the clip and each mask body bump **448** causes the clip or the mask body, or both, to deflect to a deflected condition until each bump **448** reaches a corresponding recess **447**. Once the clip has been fully engaged with the body, each bump **448** locates within a corresponding recess **447**, and the clip or body, or both un-deflect from the deflected condition to an un-deflected or partially deflected condition, the parts being clipped or snapped together in a fully engaged position. Preferably the clip or the mask body or both remain in a slightly deflected condition when fully engaged together.

The recesses **447** may be formed by having a second series of bumps on the clip, each recess effectively created, by a rear shoulder of a bump. In this arrangement, interference between bumps on the clip and bumps on the mask body occurs until the clip bumps and the mask body bumps pass to sit adjacent one other in an engaged position.

As best shown in FIGS. **39a** and **39d**, the clip **442** preferably has a relatively long lead in, or ramped profile **449**, leading to the clip recess **447**. This lead in section preferably extends the full inside perimeter length or substantially the full inside perimeter length of the clip **442**. Preferably the lead-in section extends at least 50% of the full perimeter length of the clip.

Preferably each recess **447** is located immediately behind the lead-in section. The lead-in section assists with the attachment of the clip to the mask body. The clip **442** or mask body **430**, or both, are gradually deflected over the length of the lead-in section until the apex **475** of the lead-in section and

16

each mask body bump **448** pass each other. Once the bumps **448** have passed over the lead-in section, the bumps **448** locate within each corresponding recess **447**, such that there is little or no interference between the two parts **430** and **442**. The two parts un-deflect in a relatively sudden snap action compared to the gradual deflection caused by the lead, in section **449** during engagement. This arrangement provides a positive, single engagement action. The positive single engagement action provides the user with assurance that the seal assembly has been correctly fitted to the mask body. The clipping arrangement preferably generates a clipping sound as the bumps **448** located into the recesses **447**. The clipping sound provides reassurance to the user that the clip has been correctly fitted to the mask body. The seal assembly **440** may be attached to and detached from the mask body **430** many times.

Alternatively, the lead in section, or ramp, described above may be provided on the mask body, as shown in the alternative embodiments of FIGS. **39b** and **39c**.

The lead in or ramped section **449** has a length to height ratio of approximately 3 to 7. In the preferred embodiment the lead in section has a length to height ratio of around 5. That is, for a ramp length of around 5 mm, the ramp height is around 1 mm. The lead in section ratio is best identified in FIG. **43**, where the ramp length B is around five times the ramp height A.

The ramp section results in a seal clip cross section with a relatively high width to height ratio. The cross section of the preferred form of the seal clip has a width to height ratio of around 2. Once the seal **443** is attached to the clip **442**, the cross section of the seal assembly **440** at the seal clip has a width to height ratio of around 1.5-2, with the shorter dimension transverse to the direction in which the clip is engaged to the mask body. Preferably this ratio is around 1.8.

In the preferred embodiment of FIG. **39**, and in the alternative embodiments of FIGS. **39b** and **39d**, the clip **442** interfaces with the mask body such that the clip engages to an outwardly facing surface of the mask body. However, in the alternative embodiment of FIG. **39c**, the clip **442** interfaces to an internal or inwardly facing surface of the mask body.

A series of bumps **448** and recesses **447** around the perimeter of the mask body and clip have been described above. The bumps and recesses are located so that the seal assembly may be disengaged from the mask body by squeezing the sides or opposite perimeter portions of the clip, to deflect the clip and disengage the bumps **448** from the recesses **447**. To disengage the clip from the mask body, opposite perimeter portions of the clip are squeezed at positions where bumps **448** are absent, allowing the clip to deflect, to 'pop' the bumps out of the corresponding recesses. Given the ratio of the seal assembly cross section at the clip, as described above, the clip is relatively thin transverse to the direction in which the clip is engaged to the mask body. The thin clip is relatively easy to deflect by squeezing the opposite perimeter portions in a direction transverse to the direction in which the clip engages to the mask body, to easily deflect the clip from the mask body.

Alternatively, a continuous bump extending fully around the mask perimeter may be utilised to provide the snap interface between the seal assembly **440** and the mask body **430**. In this configuration, the bump may not have a constant height all the way around the mask perimeter. Having a continuous bump with different heights may allow the clip to be disengaged from the mask body by squeezing the sides or opposite perimeter portions of the clip, to deflect the apex **475** of the lead in section **449** of the clip **442** past a corresponding higher portion of the continuous bump.

17

Alternatively the clip **442** may have a continuous recess passing around the full perimeter or substantially the full perimeter of the clip, the recess being located immediately behind the lead-in section **449**, the mask body bump **448** passing over the lead in section before clipping into a portion of the continuous recess.

In alternative embodiments such as the embodiments shown in FIGS. **39b** and **39c**, the recesses **447** may be provided in the mask body **430**, and the corresponding bumps may be formed on the mask clip **442**.

The face seal assembly **440** may include at least one wing portion **444** to assist a user to disengage the face seal assembly from the mask body. The wing portions **444** provide a gripping flange to pull the clip **442** away from the mask body **430**.

In a further alternative embodiment, the clip may be clipped to the mask body in a permanent engagement. With reference to FIG. **39e**, the mask body **430** has a series of protrusions **481**. Each protrusion has a ramped surface **482** and an abutment surface **483**. For each body protrusion **481**, the mask clip **442** has a corresponding protrusion **484**, each mask clip protrusion having a ramp surface **485** and an abutment surface **486**. Alternatively, a single continuous protrusion **481** may pass around the perimeter of the mask, with a corresponding continuous protrusion **484** passing around the perimeter of the clip. During an assembly process, the seal assembly clip **442** is interfaced to the mask body in a pressing operation, the mask body and mask clip are pressed together. The mask body, or the mask clip, or both deflect as the ramp surfaces **482** find **485** contact, and slide past one another. Once each mask body protrusion **481** and mask clip protrusion **484** pass each other, mask body **430** or clip **442**, or both, return to an un-deflected or partially deflected condition, and mask body protrusion abutment face **483** abuts against clip protrusion abutment face **486**, retaining mask, body **430** and clip **442** together. The abutment faces **483** and **486** are aligned substantially laterally relative to the direction in which the clip and body are pressed together. With the abutment faces arranged laterally, or substantially perpendicular to the pressing direction, the clip **442** may not be removed from the mask body easily, creating a substantially permanent joint between the clip and the body.

This alternative embodiment is useful for disposable masks that are disposed of after a single use. Such an embodiment is useful in simplifying the manufacturing process. During manufacture, moulding the seal **443** to the seal clip **442** may be easier than moulding the seal **443** directly to the mask body **430**. Once the seal is moulded or attached to the seal clip as in any of the embodiments described above, the subsequent operation of pressing the clip **442** and mask body **443** together is a relatively simple assembly operation.

As best shown, in FIG. **37** and FIG. **39a**, the seal preferably has a bearing surface **451** extending around the perimeter of the clip. The seal bearing surface **451** faces a corresponding bearing surface **452** on the mask body. The seal bearing surface and the mask bearing surface are in contact when the seal assembly is attached to the mask body in a butting engagement. When the seal assembly **440** is attached to the mask body **430**, the seal **443** at tire bearing interface is compressed so that a sealing interface is formed between the seal assembly and the mask body. Preferably, the clip has a raised ridge **445** running around the inside perimeter of the clip. The seal **443** is compressed by being squashed between the raised ridge **445** and the mask body bearing surface **452** when the seal assembly **440** is attached to the mask body **430**.

To assist with creating a good seal between the seal assembly and the mask body, a continuous rim **453** may be provided

18

on the seal bearing surface **451**. The rim provides a small contact area in contact with the mask, body bearing surface **452**. The small contact area allows a relatively high compression of the rim, and therefore effective seal, for a relatively small seal assembly to mask body engagement force.

Profiled Seal Clip

The seal **443** is shaped to approximately match the facial contours of a user's face. For the preferred form of the nasal mask shown in FIGS. **34** to **38**, the face seal is contoured to approximately match the facial contours of a user around the user's nose, from the bridge of the nose, continuing down the cheek regions adjacent each side of the user's nose and across the user's philtrum area. In particular, there is an indented section **454** intended to fit over the bridge of the patient's nose, a cheek contour **455** on each side to follow the cartilage extending from the middle of the user's nose, and an indented section **456** to seal around the philtrum area of the user.

The present shape of the seal is chosen to 'approximately match' the facial contours of a range of users. To approximately match tire contours of a user's face, the seal is contoured in three dimensions, that is, shaped to fit around a user's nose, and contoured in a direction substantially normal to a user's face, as described above and shown in the accompanying figures.

Similarly, if the invention was applied to a full face mask covering a user's nose and mouth, the face seal would be shaped to approximate the facial contours of the user's chin and wider cheek regions.

As best shown in FIG. **42**, the seal, assembly clip **442** and the rear portion, or back edge **452** of the mask body are shaped to generally follow the contours of the user's face. Shaped to 'generally follow', means that the contoured shape of the portion of the seal in contact with a user's face is generally replicated in the shape of the clip. The profile of the clip and the profile of the seal in contact with the user's face are therefore similar. The main difference in the shape of the clip and the shape of the portion of the seal in contact with the user's face is that the shape of the clip does not include the indent **455** in the cheek contour portion of the seal, the shape of the clip being flatter in this region. The profiled clip allows the walls **457** of seal assembly **440** to have a generally constant depth around the circumference of the seal **443**. Preferably the wall depth varies by less than around one third of the deepest wall depth. A generally constant wall depth helps the seal to apply even pressure to the face around the circumference of the seal. The profiled seal clip **442** and mask body **430** also helps to minimise the size of the mask assembly. Minimising the size of the mask is an important feature for a comfortably fitting mask. A small size provides a lightweight mask that is more comfortable to wear and less obstructive to the user.

A profiled seal assembly clip **442** and a corresponding profiled mask body **430** provides the additional benefit that a small amount of misalignment may be corrected when fitting the seal assembly to the mask body due to the shape of the parts. For example, the inventors have found that the profiled shape of the clip and mask body, combined with the ramp section **449** that extends the full perimeter length or substantially the full perimeter length of the clip, automatically corrects an angular misalignment of approximately 5 degrees when engaging the clip to the mask body. When pushing the clip and body together, misalignment is corrected as a portion of the mask body contacts the lead in section **449** of clip **442**. For example, given a small amount of angular misalignment between the clip and mask body, the initial contact between the clip and mask body occurs at a first position on one side of the nasal bridge region of the mask body and at a



second position on the mask body diametrically opposite the first position. The two positions of the mask body in contact with the clip are angled partially in line with the direction in which the clip is engaged to the mask body. As engagement force is applied to the clip and mask body, the angled shape of the clip and mask body causes the clip and the mask body to slide into alignment until the clip and mask body snap together. In prior art masks with a planar interface between the mask body and seal clip, the interface between the clip and the mask body is transverse to the direction in which the clip engages to the mask body; the seal clip and the mask body must be accurately aligned in order to correctly fit the clip to the body.

#### Inflatable Seal

Preferably the seal **443** includes a thin region **426**. The thin region **426** is a region formed in the seal **443** which is thinner than the remainder of the cross-sectional thickness of the seal **443**. In the preferred embodiment the thin region is in the nose bridge region, the extent of which is indicated by line **427** in FIG. **36a**. The thin bridge region **426** is shown to extend approximately halfway down the sides of the seal from the apex **458**. Alternatively, the thin region **426** may extend around the perimeter of the seal **442**, as indicated by line **27a** in FIG. **36a**.

In particular, the edge portion **490** must be thicker than region **426** so as to provide strength to prevent the seal losing its shape under typical CPAP pressures. The seal thickness is also thicker at the interface between the seal **443** and the clip **442**, to provide strength in the joint between the seal **442** and the clip **442**.

For example, the thick portions of the seal may have a thickness of around 0.3 to 0.6 mm. The thin region has a thickness that is in the range of around 20-80% of the thickness of the rest of the seal, that is, a thickness of around 0.05 mm-0.5 mm. Preferably the thin section is ultra thin with a thickness of around 0.05 mm-0.2 mm. In the preferred embodiment, the ultra thin region reduces the pressure on a patient's nose in the nasal bridge region, compared to when a seal does not have any reduced thickness section. Furthermore, a thin region **426** in the seal **443** allows for different sized patient's to comfortably use the mask and seal of the present invention.

In use, when a force is placed against the seal **443** the thin region **426** will yield more than the rest of the seal **443**. Therefore, this region **426** is more flexible and allows for added patient comfort.

In addition to being more flexible, due to the thin region being so thin, in the preferred embodiment the thin region **426** inflates as the CPAP pressure is applied to the mask.

Prior art masks include seals that inflate under typical CPAP pressures. However, prior art nasal masks inflate to a preformed shape or a displaced preformed shape. The preformed shape is loose when not in use. In use, the loose shape fills with air or gases and is supported in the preformed shape or a displaced preformed shape by the air or gases at positive pressure being supplied by the CPAP system. The prior art mask seal does not inflate to an elastically stretched state significantly larger than the molded or formed shape of the un-pressurized seal. For example, prior art mask seals include a bellows section which is loose when not in use. When in use, the bellows section fills up with air. The seal material of the bellows section is not significantly stretched, as the material thickness of the bellows section does not allow for significant elastic stretch under normal CPAP pressures, the material of the bellows section being too thick.

In the preferred embodiment of the present invention, the ultra thin section **26** inflates under CPAP pressure to an elas-

tically stretched state significantly larger than the molded or formed shape of the seal. The ultra thin region provides a seal that remains tight, with no loose sections that may crimp or fold, when un-deflated. Inflation by typical CPAP pressures to a significantly stretched state helps the sealing performance of the mask, as the seal elastically inflates to the facial contours of the user's face and allows for more movement of the mask on the user's face. The ultra thin region **426** inflates to an elastic stretch condition under typical CPAP pressures of 4 cm-25 cm H<sub>2</sub>O head. The seal of the present invention includes a thin region that inflates under typical CPAP pressures to an elastically stretched condition with strain in the thin region greater than 0.1. That is, the length E of the thin region as shown in FIG. **46** increases by at least 10% when pressurized under normal CPAP pressures. In FIG. **46**, seal **443** drawn in continuous line type shows the thin region **426** un-pressurized. The dashed lines show the seal **443** pressurized, with the thin region **426** pressurized to a significantly stretched condition, with an elastic stretch of approximately 10%. Preferably the thin region inflates under typical CPAP pressures to an elastically stretched condition with strain in the thin region greater than 0.2.

The seal is typically formed during manufacture by injection molding. Such a thin region has been achieved in manufacture by injecting the seal material into a closed seal mold via the thin region **426**. Having the injection point within the thin region allows better control of the seal forming process and allows the ultra thin region to be formed successfully. Injection via the thin section is preferred.

The thickness figures provided above are preferable for silicone with a shore A hardness of approximately 40. If an alternative silicone or other rubber material with similar properties to silicone is used, the thickness figures should be adjusted. The thickness figures may be adjusted inversely proportionally with respect to the hardness or elasticity of the material. For example, for a material with a Shore A hardness of 20, the seal thickness may be twice as thick as the figures provided above.

As best shown in FIG. **36a**, the thin region **426** on the seal **443** preferably does not extend completely to the outer edge **459** of the seal **443**, but grows in thickness in region **490**. This is because the outer edges of the seal **459** when thicker are less prone to tearing. Also thicker region **490** provides structural support to the seal **443** so that seal **443** maintains its perimeter length in contact with the user's face when inflated, the perimeter length extending around the seal opening **491**.

In addition, as shown in FIG. **39a**, the seal preferably has a bead **460** on the perimeter edge of the seal surrounding the seal opening **491**. Preferably this bead is formed at the inside surface **461** of the seal. The diametrical cross-section of the bead will typically be in the range 0.4 mm-1.0 mm. Preferably the bead diameter will be about 0.5 mm. The bead provides additional strength to the edge of the seal, to add additional strength and support at the perimeter of the seal opening **491** and reduce the likelihood of the seal being torn if the seal is inadvertently caught or snagged by a foreign object.

Alternatively, the seal **443** may be molded without an opening. Opening **491** is then cut out of the molded seal in a cutting operation, following the molding process. The opening **491** may be cut with a knife or press in the cutting operation. The cutting operation results in a clean edge which is less susceptible to tearing compared to a molded edge. For a seal manufactured in this way, a bead **460** is less important.

An inflatable seal may also be incorporated into the mask embodiment of FIG. **23**. For example, thin region **203** could have a thickness of around 0.05 mm to 0.2 mm, so that this

## 21

region inflates under typical CPAP pressures to an elastically stretched state, as described above in relation to the embodiment of FIG. 36a.

As shown in FIG. 24, the length 217 of the thin region increases by at least 10% when pressurised under normal CPAP pressure. The stretched pressured seal is indicated by the dashed lines 216. The edge portion 209 of seal 201 is thicker than region 203 so as to provide strength to prevent the seal losing its shape under typical CPAP pressures. The seal thickness is also thicker at the outer edge 211 as described earlier to provide strength in this area of the seal.

## Mask Cushion

The mask assembly of FIG. 34 preferably includes a mask cushion 441, as described in the similar earlier embodiment of FIGS. 21 to 23.

In the interface 402 of FIG. 34, the cushion 441 is provided around the periphery of the mask, and is surrounded by the seal assembly 440. When using a thin seal, the cushion 441 provides support to the seal assembly 440 to achieve an effective seal onto the face of the user to prevent leakage.

One end 462 of the mask cushion is shaped to match the shape of the seal in contact with the user's face, and an opposite end 463 is shaped to match the mask body.

As described above, the seal assembly clip 442 and mask body 430 generally follow the contours of the user's face, and therefore provide a generally constant seal depth between the mask body 430 and seal surface in contact with the user's face. The cushion in the preferred embodiment therefore has a wall 464 with a generally constant depth. The constant depth cushion helps to provide an even pressure to the face around the periphery of the mask.

The cushion is constructed of a resilient material, for example polyurethane foam, to distribute the pressure evenly along the seal around the patient's face. In other forms the cushion 441 may be formed of other appropriate material, such as gel, silicone, or other composite materials.

In the preferred embodiment, the mask cushion includes a raised bridge 465 in the nasal bridge region. The raised bridge 465 can also be described as a cut out section made in the cushion, the cut out being on the mask body end 463 of the cushion. As the raised bridge 465 is unsupported by the mask body 430, it is much more flexible and results in less pressure on the nasal bridge of the patient.

In other forms, the cushion may be provided with other contours or cut outs on the mask body end 463 of the cushion, so that in the areas where there are regions cut out, the cushion is more flexible.

Preferably, the extent of the raised bridge portion 465 of the cushion substantially aligns with the extent 427 of the thin bridge section 426 of the seal described above.

The cushion 441 is located around the outer periphery of the mask body, contacting the mask body except for in the raised bridge portion 465 of the cushion. As best shown in FIG. 37, the cushion is located in a generally triangular cavity 466, the cavity continuing around the periphery of the mask body, terminating at each side of the nose bridge region 467 of the mask, where the raised bridge portion 465 of the cushion does not contact the mask body 430. The cavity 466 is generally formed by two spaced apart walls 476 and 477.

The cushion 441 in the preferred embodiment is a separate item, the seal assembly 440 lining in place over the cushion to hold it in place within the mask assembly 402. Alternatively, the cushion may be permanently or releasably attached to the seal assembly 440 so that the seal, seal clip and cushion may be provided as a single assembly. The cushion may be permanently or releasably attached to the seal 443 or to the seal

## 22

clip 442. Alternatively, the cushion may be permanently or releasably attached to the mask body 430.

## Exhaust Holes

In use the user exhales his or her breath either via an expiratory conduit, (not shown in the Figures) or directly to the atmosphere. In use, the user may exhale a portion of his or her breath via the mask assembly, that is, back into the inspiratory side of the mask assembly. In prior art masks, exhaust holes are provided in the connector 423, to assist with flushing exhaled air from the mask assembly. In the preferred form of the patient interface, the mask body 430 has exhaust flow holes 425. The exhaust holes 425 in the mask body 430 improves the flushing of exhaled air from the assembly. The exhaust holes 425 consist of 5-50 holes, each hole with a diameter of 0.3 mm-1.5 mm.

In a preferred form the exhaust holes 425 are provided through the front of the mask body substantially perpendicular to the front of the mask body 430. Alternatively, the exhaust holes may pass through the front of the mask body at an angle, for example, angled approximately 45 degrees upwards, the outlet of the exhaust holes at the outside surface of the mask body being higher than the inlet of the exhaust holes at the inside of the mask body.

The holes may be provided directly through the mask body 430. Alternatively, the holes may be formed in a separate rubber or plastic insert, the insert being fitted to a corresponding aperture (not shown) in the mask body 430.

The exhaust holes 425 may be provided through the front of the mask body in an upper portion of the mask body. Alternatively, the holes 425 may be provided through a side or sides of the mask body 430, in an upper portion of the mask body. Alternatively, the holes may be provided in a lower portion of the mask body, for example, adjacent a bottom edge of the mask body.

As described above, the mask body 430 preferably includes exhaust holes 425 to allow exhaled breath to be vented from the mask assembly. Alternatively, or in addition to the vent holes, the mask assembly may provide additional vent paths between the seal assembly 440 and the mask body 430, as shown in FIGS. 41a to 41c. The bearing surface 452 of the mask body in contact with the rim 453 or seal assembly bearing surface 451 may not extend continuously around the perimeter of the mask body. Discrete portions 468 of the rear edge of the mask body may be removed, providing a flow path from the mask assembly to the atmosphere. Alternatively, discrete portions 469 may be removed from the rim 453, or the seal assembly bearing surface 451, or both.

For clarity, discrete portions 468 and 469 have been shown enlarged in FIGS. 41a and 41b. In practice, the flow path via either discrete portions 468 or discrete portions 469 should be similar to the flow path via holes 25, discrete portions 468 or discrete portions 469, or both, being provided in place of holes 425.

Vent paths provided by discrete portions 468 or 469 or both are visually hidden from the exterior of the mask. This arrangement provides a desirable look to the mask assembly.

Alternatively, holes 470 through the mask body 430 adjacent to the mask bearing surface 452 may be provided to vent exhaled air. Space 478 is a part annular channel space passing around the mask, the channel being formed between the mask body 430, the mask cushion 441 and the seal assembly 440. Exhaled air passes into the channel space 478 via the raised nasal bridge region of the mask. Such holes 470 provide flow paths from the mask to the atmosphere via channel space 478. Holes 470 are provided through a side of the mask body which is partially concealed by a portion of clip 442. The

23

holes 470 are therefore partially visually hidden from the exterior of the mask assembly in use.

In order to improve venting of exhaled air from the mask, a flow path 479 may be provided directly from the interior of the mask to the vent holes 470. In this embodiment, exhaled air does not need to pass via the raised nasal bridge region and channel space 478, but may pass directly from the interior of the mask, via flow path 479 and through holes 470. Flow path 479 is provided by a cut-out region in the mask cushion 441, indicated by the dashed line in FIG. 40a. Similar cut out portions are provided in the spaced apart walls 476 and 477 which form cavity 466. The venting of exhaled air is assisted by the downwards flow path 479, with holes 470 preferably being located in a bottom side portion of the mask, body 430. When a user uses the nasal interface of the present invention, air exhaled from the user's nostrils is exhaled substantially in line with the flow path 479 and holes 470, improving the vent flow path.

#### Circumferential Thin Portion

The seal 201, 443 may comprise a thin portion approximately circumferentially aligned with the circumferential perimeter of the seal. The circumferential thin portion 4200, as shown in FIGS. 47A to 47D, may extend continuously around the full circumference or perimeter of the seal. Alternatively, the circumferential thin portion 4200 may extend around only a portion of the circumference of the seal 201, 443.

The circumferential thin portion 4200 provides flexibility in the wall 457 of the seal. This flexibility can assist with allowing the seal area in contact with the user's face to move laterally with respect to the mask body and head gear. Allowing lateral movement can assist with maintaining an effect seal against the user's face. The circumferential thin portion can provide a decoupling between the mask body and the area of tire seal in contact with the user's face.

Typical CPAP pressures applied to the interior of the mask assist with providing support to the seal so that the seal 201, 443 does not collapse in the region of the circumferential thin portion when pressure is applied between the seal and the user's face by the head gear. The seal 201, 443 may be used with or without an inner cushion 202, 441.

As shown in the partial cross section of FIG. 48, the thin section 4200 may be formed at an interior surface of the seal wall. Alternatively, the thin portion may be formed at an exterior surface of the seal wall, or may be formed centrally with respect to the cross section of the seal wall.

As shown in FIG. 47A, the circumferential thin portion 4200 may have approximately constant width around the circumference of the seal. Alternatively, as shown in FIG. 47B, the circumferential thin portion may comprise wide portions and narrow portions. For example, the circumferential thin portion may be wider in the nasal bridge region, or the chin region or both compared to other circumferential positions around the seal.

The width of the circumferential thin portion may vary at a repeating pitch around the circumference or a portion of the circumference of the seal. For example, the width may vary at a pitch between wide and narrow sections of between approximately 10 mm to 20 mm. As shown in FIGS. 47C and 47D, the width varies at a repeating pitch in the chin and lower cheek regions of the seal.

Alternatively, as shown in FIGS. 47E and 47F, the circumferential thin portion may comprise one or more thin portions 4200A, 4200B extending in a circumferential direction around the seal; thin portions 4200A, 4200B may be in the nasal bridge region or chin region or both.

24

A varying width circumferential thin portion may provide different facial sealing forces at different positions around the seal perimeter. For example, it is desirable to reduce the sealing force in the nasal bridge region. By widening the circumferential thin portion in the nasal bridge region, the seal 201, 443 will provide less resistance in this area against the face of a user.

The circumferential thin portion may have a thickness of approximately 0.2 mm to 0.3 mm, the other sections of the seal wall having a thickness of approximately 1 mm.

The foregoing description of the invention includes preferred forms thereof. Modifications may be made (hereto without departing from the scope of the invention as claimed).

#### We claim:

1. A mask assembly for use as part of an apparatus for supplying a flow of respiratory gases to a user, the mask assembly comprising:

a rigid mask body including an inlet through which said flow of respiratory gases are provided to an interior of said mask assembly,

a mask seal assembly coupled to said mask body in use, said mask seal assembly including a mask seal having a molded shape when unpressurized to approximately match contours of a face of the user and in use substantially seal against the face, said mask seal defining an opening adapted in use to place the user in communication with an interior of said mask assembly, said opening comprising an apex in a nasal bridge region of said mask assembly,

said mask seal comprising a thin region and a thick region, said thin region extending along an inner periphery of the mask seal and being located in said nasal bridge region and extending downward beyond said apex of said opening, wherein the thin region ends in cheek regions of the mask seal, said thick region comprising a remainder of the inner periphery of said mask seal and including a first portion and a second portion, the first portion extending along an outer periphery of the mask seal towards the mask body and the second portion extending along an inner edge encircling said opening between said thin region and said opening, in use said inner periphery adapted to be in contact with the face of the user, said thin region inflating under typical CPAP pressure to an elastically stretched condition significantly larger than said molded shape, and the mask seal being formed of a seal material having a strain greater than 0.1 when in said elastically stretched condition.

2. The mask assembly as claimed in claim 1, wherein said thin region has a thickness of 0.05 mm-0.2 mm, said seal material having a Shore A hardness of around 40.

3. The mask assembly as claimed in claim 1, wherein said seal material is silicone.

4. The mask assembly as claimed in claim 1, wherein said mask seal is manufactured by injection molding in a closed mold, a point of injection into the closed mold being in said thin region of said mask seal.

5. The mask assembly as claimed in claim 1, wherein the second portion of the thick region forms a bead on an inside surface of said mask seal.

6. The mask assembly as claimed in claim 5, wherein said bead is about 0.5 mm diameter in cross section.

7. A patient interface for use as part of an apparatus for supplying a flow of respiratory gases to a user, the patient interface comprising: headgear, a mask assembly as claimed in claim 1 and comprising at least one fitting adapted to attach said mask assembly to said headgear.

**25**

8. An apparatus for supplying a flow of respiratory gases to a user, the apparatus comprising:

- a blower unit adapted to provide a stream of pressurized gases,
- a humidifier unit adapted to receive said stream of pressurized gases and to heat and humidify said stream of pressurized gases,
- a patient interface,
- a conduit connecting said patient interface and said humidifier unit so that said patient interface receives said stream of pressurized gases after being heated and humidified, said patient interface comprising headgear and a mask assembly as claimed in claim 1 and comprising at least one fitting adapted to attach said mask assembly to said headgear.

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**26**

15